# IDENTIFICATION OF FACTORS THAT REDUCE MATHEMATICS ANXIETY OF PRESERVICE ELEMENTARY TEACHERS IN MATHEMATICS CONTENT COURSES

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by

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## Dedication

This dissertation is dedicated to four very special people in my life – my parents, Barbara Holley Viator and the late Preston Joseph Viator; my son, Marcus Joseph Plaisance; and my husband, Mark David Plaisance.

Both of my parents instilled in me the deep desire for learning and the confidence to succeed in my academic pursuits. In my preschool years prior to mandatory kindergarten and the notion of home schooling, my mother provided me and my sister, Carolyn, the benefit of a kindergarten education. My mother "played school" with us and taught us the basics of reading and mathematics. I remember my father calling home at the end of a workday to find out if we needed anything – like another "Big Chief" tablet. From those early days and throughout my academic career, I always knew that my parents believed in me.

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## TABLE OF CONTENTS


Page

Dedication ..... i

Acknowledgements ..... ii

List of Tables ..... vii

Abstract ..... viii

CHAPTER I INTRODUCTION ..... 1

Statement of the Problem ..... 4

Purpose and Significance of the Study ..... 5

Research Question ..... 6

Definition of Terms ..... 6

Limitations of the Study ..... 7

Assumptions of the Study ..... 7

CHAPTER II REVIEW OF THE LITERATURE ..... 8

Understanding Mathematics Anxiety ..... 8

Origins of Mathematics Anxiety ..... 13

Mythical Origins ..... 14

Miscellaneous Origins ..... 17

Instructional-Related Origins ..... 19

Effects of Mathematics Anxiety ..... 25

Reduction and Prevention of Mathematics Anxiety ..... 29

Development of the Mathematics Anxiety Rating Scale .....36

Summary .....43

CHAPTER III METHODOLOGY .....45

Description of the Setting .....45

Description of the Participants .....46

Research Question .....47

Instrumentation .....47

Student Demographic Data Form .....49

Mathematics Anxiety Rating Scale – Short Version .....49

Interview Protocol .....50

Electronic Mail Questionnaires .....51

Design of the Study .....52

Description of Interview Procedures .....52

Description of Mathematics Content Courses .....53

Data Collection and Analysis .....57

CHAPTER IV RESULTS .....60

Demographic Profiles .....62

Interview and Questionnaire Responses .....66

Question 1 .....67

Question 2 .....74

Question 3 .....83

Question 4 .....87

Summary .....93

CHAPTER V DISCUSSION ..... 94

Interpretation of Results ..... 97

Conclusions ..... 109

Implications ..... 111

Recommendations ..... 112

Summary ..... 113

BIBLIOGRAPHY ..... 115

APPENDICES ..... 125

A. Instrumentation ..... 126

Interview Questions ..... 127

Demographic Questionnaire ..... 129

E-Mail Questionnaire 1 ..... 130

E-Mail Questionnaire 2 ..... 131

E-Mail Questionnaire 3 ..... 132

B. Course Syllabi ..... 133

Survey Course ..... 134

Number Sense and Problem Solving Course ..... 136

Measurement and Geometry Course ..... 139

Proportional and Algebraic Reasoning Course ..... 142

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## LIST OF TABLES


| Table | | Page |
|---|---|---|
| 1 | Demographic Information for Students Demonstrating Reduction in Mathematics Anxiety Based on MARS-SV Scores | 63 |
| 2 | Demographic Information for Students Demonstrating Increase in Mathematics Anxiety Based on MARS-SV Scores | 64 |
| 3 | Responses to Question 1 | 99 |
| 4 | Responses to Question 2 | 100 |
| 5 | Responses to Question 3 (Students Demonstrating Reduction) | 105 |
| 6 | Responses to Question 3 (Students Demonstrating Increase) | 106 |
| 7 | Categorized Responses to Question 3 | 107 |

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Identification of Factors that Reduce Mathematics Anxiety of
Preservice Elementary Teachers in Mathematics Content Courses

## ABSTRACT

The purpose of this study was to identify factors that reduce mathematics anxiety in preservice elementary teachers enrolled in mathematics content courses. Students enrolled in ten sections of four different, required mathematics content courses in one specific semester were chosen as the population for this study. Approximately 180 students were administered the Mathematics Anxiety Rating Scale – Short Version (MARS-SV) at the beginning of the semester and upon completion of the semester. The sample included 28 students – 15 students whose mathematics anxiety reduced based upon results of the MARS-SV and 13 students whose mathematics anxiety increased based upon results of the MARS-SV.

The study was qualitative in design. Qualitative methods included individual interviews and electronic mail questionnaires. The 15 students whose mathematics anxiety reduced participated through individual interviews and follow-up electronic mail questionnaires. The 13 students whose mathematics anxiety increased participated through electronic mail questionnaires.

The findings of this study indicate that preservice elementary teachers' attributed their reduction in mathematics anxiety to some teacher-related behaviors. These behaviors included teachers' willingness to help and methods of teaching. Specific

teaching methods cited were step-by-step explanations and hands-on activities. In addition, findings suggest that preservice elementary teachers believe that certain instructional strategies would be the most effective way to reduce the mathematics anxiety of preservice elementary teachers. The instructional strategies recommended included providing test reviews with sample test questions, explaining mathematics concepts thoroughly, incorporating hands-on activities into courses, and making the mathematics content relevant and useful as a future teacher.

The researcher suggests further study investigating the details of teaching methods and instructional strategies utilized by instructors. Additionally, because the instructors of these preservice teachers were not a component of this study, the researcher recommends examining the views of instructors including their understanding of mathematics anxiety and what, if any, techniques do they use to address the mathematics anxiety of their students.

# CHAPTER I

# INTRODUCTION

After sharpening his pencil, a fourth-grade student sits at a desk waiting for class to begin. He opens his notebook to a clean page. From all observations, the student is relaxed. The teacher then walks to the blackboard and writes a phrase. The student starts twirling the pencil and sits up straight in the desk chair. Within a few seconds, he is squirming. He no longer looks relaxed; in fact, he is sweating and appears to be quite nervous because the teacher has just written "Addition of Fractions" on the blackboard.

The nervous reaction of sweating and squirming has been an episode of mathematics anxiety for this fourth-grade student; this student is a victim of mathematics anxiety.

Tobias and Weissbrod (1980) defined mathematics anxiety as "the panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem" (p 63). In *Overcoming Math Anxiety*, Tobias (1978) described mathematics anxiety as a tense and anxious feeling that may obstruct one from manipulating numbers and/or solving mathematical problems.

Mathematics anxiety has been attributed to certain events during the course of one's educational career. Zopp (1999) conducted a study with adults over age 25 and concluded that certain life events, specific educational episodes, and a general lack of encouragement are origins of math anxiety. In a separate study, Jackson and Leffingwell

(1999) found that only seven percent of the participants in the study had all positive experiences in mathematics classes from the kindergarten level through the university level. The other 93 percent of the participants reported negative experiences that generally occurred at certain times – grades three and four of elementary school, grades nine through 11 of high school, and the first year of college. At each of these levels, some participants indicated that their mathematics anxiety was associated with insensitive and uncaring teachers. Some of the subjects experienced traumatic experiences as early as kindergarten or first grade, but 16 percent of the subjects "experienced their first traumatic encounter in grades 3 or 4" (Jackson & Leffingwell, 1999, p. 588). In a separate study, Swetman (1994) determined that students often first experience mathematics anxiety in fourth grade.

Unfortunately, "most math anxiety has its roots in the teachers and the teaching of mathematics" (Fiore, 1999, p. 403). Bad experiences with math teachers can result in math anxiety (Tobias, 1978). Greenwood (1984) indicated that math anxiety usually "results more from the way the subject matter is presented than from the subject matter itself" (p. 662). Although Lazaruz (1974) believed that the roots of mathematics anxiety can be traced to elementary and secondary grades, he found that the problem does not surface until later. The problem is masked, because in many situations students are able to succeed early in mathematics by memorizing rules and formulas for testing (Skemp, 1979).

Mathematics anxiety is not limited to students. Victims of mathematics anxiety include teachers, especially elementary teachers (Williams, 1988). Reports indicate that a disproportionate number of elementary teachers experience substantial levels of

mathematics anxiety (Buhlman & Young, 1982; Levine, 1996). Kelly and Tomhave's study (1985) compared elementary education majors' mathematics anxiety levels to four other math-anxious college groups and found, interestingly, that the elementary education majors had the highest levels of mathematics anxiety. Hembree (1990) also found that mathematics anxiety is widespread among preservice elementary teachers.

In a 1982 study, Chavez and Widmer found that elementary teachers felt their own performance was acceptable in elementary school. About half of the teachers interviewed had negative experiences and/or problems at the secondary and university levels. Reasons for the problems included "math content, inadequate, impatient, or sarcastic teachers, low grades ('the only D in my life!'), and parents' impatience with lack of success in math" (Chavez & Widmer, 1982, p. 387). Despite the negative experiences, the teachers were positive about teaching mathematics. They worked diligently to spare their own students from similar "unpleasant experiences with numbers" (Chavez & Widmer, 1982, p. 387).

Considering these findings, it is important for teachers at all levels to consider their impact on students in relation to mathematics anxiety. Because research indicates that students usually exhibit the first signs of mathematics anxiety in elementary school (Jackson & Leffingwell, 1999; Swetman, 1994; Tankersley, 1993) and that mathematics anxiety can be transferred from teacher to students (Fiore, 1999; Lazarus, 1974; Martinez, 1987; Sovchik, 1996; Wood, 1988), elementary teachers should be prepared to provide positive mathematical experiences that reduce mathematics anxiety.

Mathematics content instructors of future elementary teachers should be

aware of what they can do to reduce future elementary teachers' mathematics anxiety to provide these positive mathematical experiences.

## Statement of the Problem

Research indicates that teachers can transfer mathematics anxiety to their students (Fiore, 1999; Lazarus, 1974; Sovchik, 1996; Wood, 1988). Research also indicates that students first experience mathematics anxiety in elementary school (Jackson & Leffingwell, 1999; Swetman, 1994; Tankersley, 1993). In a meta-analysis of 151 mathematics anxiety studies, Hembree (1990) concluded, "[M]athematics anxiety is related to poor performance on mathematics achievement tests" (p. 33). Mathematics anxiety was also found to relate inversely to positive mathematics attitudes and is "bound directly to avoidance of the subject" (Hembree, 1990, p. 33).

Mathematics content courses are taught in the mathematics departments of universities and taught by mathematics instructors or mathematics professors who are "mathematicians." Cuff (1993) states that mathematicians often do not understand students who are victims of mathematics anxiety. Teachers of mathematics content courses for elementary teachers tend to ignore the problem of mathematics anxiety and "continue to teach the familiar and easy to teach area – the content" (Cuff, 1993, p. 221). However, teaching mathematics content does not necessarily address every need of the preservice elementary mathematics teacher.

Therefore, mathematics instructors of preservice elementary teachers should make every attempt to assure that elementary teachers enter elementary schools with little or no

mathematics anxiety. In an effort to better understand mathematics anxiety, this research study investigates the following problem:

> What factors do preservice elementary teachers perceive as having reduced their mathematics anxiety while they were enrolled in a required mathematics content course?

## Purpose and Significance of the Study

The purpose of this study is to identify factors that reduce mathematics anxiety in preservice elementary teachers enrolled in mathematics content courses. Once the factors are identified, then mathematics instructors of preservice elementary teachers can be informed. In a conscious effort to reduce mathematics anxiety of preservice elementary teachers, these instructors can implement classroom strategies and/or teaching techniques employing these factors.

In a review of mathematics anxiety research, Berman (2003) stated, "teachers' own math anxiety can interfere with students' learning and often create math anxiety for their students" (p. 173). Research provides "evidence that math-anxious elementary teachers may affect their pupils adversely" (Wadlington & Bitner, 2001, p. 391). Students' attitudes about mathematics are learned through mathematical experiences, which can take place in the elementary classroom (Johnson, 1981). In addition, research supports the idea that teachers can transmit negative attitudes toward mathematics and/or mathematics anxiety to students (Fiore, 1999; Kelly & Tomhave, 1985; Larson, 1983; Lazarus, 1974; Oleon & Gillingham, 1980; Sovchik, 1996; Wood, 1988).

Elementary teachers showing signs of mathematics anxiety do not demonstrate

behaviors typical of effective mathematics teachers (Tishler, 1980). Good (1979) indicated that teachers have more of an influence on student achievement than that of the teaching methods or the curriculum utilized. It is imperative to identify and to understand the factors that reduce the mathematics anxiety of preservice elementary teachers in order to reduce their mathematics anxiety.

If future elementary teachers have lower levels of mathematics anxiety, then it follows that their students will have lower levels of mathematics anxiety. As Williams (1988) stated in a paraphrase of a Chinese proverb:

> Tell me mathematics, and I will forget;
> Show me mathematics and I may remember;
> Involve me...and I will understand mathematics.
> If I understand mathematics, I will be less likely to have math anxiety.
> And if I become a teacher of mathematics, I can thus begin a
> cycle that will produce less math-anxious students for generations
> to come (p. 101).

## Research Question

The research question for this investigation is as follows:

> What factors do preservice elementary teachers perceive
> as having reduced their mathematics anxiety while they
> were enrolled in a required mathematics content course?

## Definition of Terms

Significant terms for this research are defined below:

***Mathematics Anxiety***: "The panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem" (Tobias & Weissbrod, 1980, p 63).

***Elementary Students*:** Individuals enrolled in grades kindergarten through sixth grade

***Elementary Teachers*:** Individuals teaching grades kindergarten through sixth grade

***Preservice Elementary Teachers*:** Individuals enrolled in a university education program with majors of pre-kindergarten through third grade or first grade through sixth grade

## Limitations of the Study

Limitations of the study include the sampling procedure and the instrumentation. In as much as the sampling procedure is not random, generalizability may be limited. With regard to instrumentation, use of the Mathematics Anxiety Rating Scale – Short Version (MARS-SV) may limit the scope of the mathematics anxiety measurement to constructs of "test anxiety" and "numerical anxiety" (Suinn & Winston, 2003).

## Assumptions of the Study

There are two basic assumptions of the study. First, it is assumed that the participants' understanding of the MARS-SV is what the researcher and the developer of the MARS-SV intended. Second, it is assumed that the participants' responses to the MARS-SV and to all questions are accurate and based upon their experiences.

# CHAPTER II

# REVIEW OF THE LITERATURE

The purpose of this study is to identify factors that preservice elementary teachers perceive as having reduced their mathematics anxiety while enrolled in a mathematics content course required for elementary education majors.

The review of the literature includes the initial section describing mathematics anxiety and its symptoms for an understanding of mathematics anxiety. Subsequent sections include discussions of the origins of mathematics anxiety, the effects of mathematics anxiety, and the methods for reducing and preventing mathematics anxiety. In each section, related studies are discussed. The final section explains the development of the Mathematics Anxiety Rating Scale – Short Version (MARS-SV), which is the instrument used in this study to identify changes in students' mathematics anxiety levels over a period of one university semester.

## Understanding Mathematics Anxiety

Mathematics anxiety is defined or described in many, but similar ways. Vinson (2001) said, "[M]athematics anxiety is more than a dislike toward mathematics" (p. 89). Smith (1997) described various reactions of mathematics anxiety victims including uneasiness when performing mathematically, avoidance of mathematics classes until the

last minute, feelings of physical and emotional illness, inability to perform on tests, and the utilization of tutors for assistance.

In *Overcoming Math Anxiety*, Tobias (1978) defined mathematics anxiety as a tense and anxious feeling that may obstruct one from manipulating numbers and/or solving mathematical problems. Richardson and Suinn (1972) defined mathematics anxiety as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of ordinary life and academic situations" (p. 551). Similarly, Chavez and Widmer (1982) defined it "as uneasiness or apprehension regarding mathematics" (p. 272).

Mathematics anxiety is sometimes referred to as math phobia. Gough (1954), a teacher, observed that a number of her students exhibited emotional troubles with mathematics. She identified this reaction as "mathemaphobia." Clawson (1991) stated that math phobia is not a disease or an affliction, but "it is a handicap that can have a dramatic impact on your life" (p. 1). Burns (1998) identified math phobia as "a widespread national problem" involving "negative attitudes and beliefs that people hold about mathematics" that seriously limit them in their immediate and future life activities (p. ix). Spicer (2004) stated that mathematics anxiety is "an emotion that blocks a person's reasoning ability when confronted with a mathematical situation" (p. 1).

Mathematics anxiety is described frequently as a learned emotional response to mathematical situations. These mathematical situations can involve participating in math class, listening to a math lecture, working math problems, and/or discussing math. Unfortunately, mathematics anxiety appears to be a learned emotional response that interferes with a person's intellectual capabilities. In a meta-analysis of 151 mathematics

anxiety studies involving third grade through post-secondary students, Hembree (1990) concluded that mathematics anxiety researchers have been practical in adopting test anxiety's theoretical base for mathematics anxiety. Similar to test anxiety, mathematics anxiety appears to be a "learned condition more behavioral than cognitive in nature" (Hembree, 1990, p. 45).

Hembree (1990) identified studies for this meta-analysis through searches of three databases: *Dissertation Abstracts, Psychological Abstracts,* and the Educational Resources Information Center (ERIC). In addition, he found other studies by tracing citations from study to study. Each study was screened against a set of rigorous criteria including using instruments producing valid scores and providing product-moment correlation coefficients with sample sizes. In the case of experiments, two groups, including a control group, had to be used. Experimental groups had to contain at least 10 subjects "for rigor in the meta-analytic tests of homogeneity" (Hembree, 1990, p. 35).

Reys, Lindquist, Lambdin, and Smith (2007) described mathematics anxiety and mathematics phobia as a gorge separating the "concrete" from the "abstract." The "concrete" is represented by modeling, manipulating, and communicating while the "abstract" is represented by generalizing, representing, symbolizing, and communicating. Various troublesome mathematics-related behavior exists in that gorge – a strong dislike of mathematics, apathy, lack of confidence, confusion, low motivation, poor performance on mathematics tests, classroom behavior problems, and misunderstandings.

Martinez and Martinez (1996) believe that in order to understand mathematics anxiety, one "must first recognize its complexity" and that "it is not a discrete condition" (p. 2). The authors stated that the path of a mathematics anxious person is rarely straight

because "math anxiety is a construct" having multiple causes and effects which interact "in a tangle" defying simple diagnosis and simple solutions (Martinez & Martinez, 1996, p. 2).

In mathematics, "the problem-solving process proceeds in a context that encompasses feelings about math from the affective domain and knowledge about math from the cognitive domain" (Martinez & Martinez, 1996, p. 2). Bessant (1995) also described mathematics anxiety as multidimensional with affective roots in addition to cognitive roots. These cognitive roots, also known as the cognitive domain of learning, may be referred to as the logical component of learning. The cognitive domain of learning mathematics has an effect on mathematics anxiety when gaps in knowledge occur, when information is mislearned, and when teaching strategies are mismatched with learning readiness (Martinez & Martinez, 1996).

The affective domain of learning may be referred to as the emotional component. Martinez and Martinez (1996) refer to the affective domain of learning mathematics as "the province of attitudes about learning math, of memories of past failures and successes, of influences from math-anxious or math-confident adults, of responses to the learning environment and teaching styles" (p. 6). The affective domain provides the framework for learning. If the framework is presented positively, students can be motivated to learn regardless of their mathematics aptitude. Hembree's (1990) correlational findings indicate that "positive attitudes toward mathematics consistently related to lower mathematics anxiety, with strong inverse relations observed for an enjoyment of mathematics and self confidence in the subject" (p. 38). However, if the

framework is presented negatively, even students with strong mathematical-learning ability can develop mathematics anxiety.

While it is possible for affective and cognitive factors to produce mathematics anxiety, there are no references made to "cognitive math anxiety" or "affective math anxiety" (Martinez & Martinez, 1996, p. 8). The initial thrust for the mathematics anxiety can come from the affective and/or cognitive domain, but the construct of mathematics anxiety "weaves them together in a stimulus-response chain reaction" (Martinez & Martinez, 1996, p. 8). Not every negative situation will start a mathematics anxiety chain reaction, but the reaction likely occurs when the negative experiences outweigh the positive experiences.

According to Smith (1997), victims of mathematics anxiety experience mathematics anxiety in a variety of ways. These experiences may range from feeling uneasy to having difficulty breathing when completing simple mathematical tasks such as calculating a tip for a restaurant bill. Physiological symptoms include rapid heartbeat, sweaty palms, nervous stomach, panic, and feelings of faintness (Cemen, 1987; Kitchens, 1995; Posamentier & Stepelman, 1990). Psychological symptoms include helplessness, fear, distress, shame, and the inability to cope (Cemen, 1987; Posamentier & Stepelman, 1990). Some mathematics anxiety victims avoid any contact with mathematics until it is absolutely necessary (Tobias, 1978). Arem (1993) believed that mathematics anxiety is similar to a disease having "clear-cut symptoms" including "negative, emotional, mental, and/or physical reactions to mathematical thought processes and problem solving, caused by discomforting or unrewarding life experiences with math" (p. 1). Tobias (1978)

stated, "[T]he first thing people remember about failing at mathematics is that it felt like sudden death" (p. 44).

## Origins of Mathematics Anxiety

Mathematics anxiety does not have a single cause, origin, or root; "it is the result of different factors" (Norwood, 1994, p. 248). Determining actual causes of mathematics anxiety has been unsuccessful since its first description in the 1950's (Gough, 1954). Kazelskis (1998) stated, "The phenomenon of mathematics anxiety has been under serious study for more than 20 years. However, the nature of mathematics anxiety, its origins, and methods to alleviate it continue to be somewhat elusive" (p. 623). Martinez and Martinez (1996) wrote:

> One person's math anxiety could be knowledge-based – the result of inadequate instruction in basic operations; another's could be tied to shaming behaviors, such as being sent to the chalkboard to work arithmetic problems. One person may have learned math anxiety from a math-anxious teacher, another from a math-anxious person. For some, anxiety may be linked to all numbers; for others, only to use some operations (p. 1).

Hadfield and McNeil (1994) suggested that origins of mathematics anxiety include intellectual, personality, and environmental factors. Intellectual factors include students' attitude, lack of persistence, self-doubt, lack of confidence in mathematical ability, and lack of belief in mathematics' usefulness (Cemen, 1987; Miller & Mitchell, 1994). Personality factors include low self-esteem, shyness resulting in reluctance to ask questions, and the idea that mathematics is a male-dominated domain (Cemen, 1987; Gutbezahl, 1995; Levine, 1995; Miller & Mitchell, 1994). Environmental factors include

negative classroom experiences, uncaring teachers, parental demands, and teacher-dominated classrooms (Dossel, 1993; Tobias, 1990).

Some researchers believe that the origin is mainly environmental (Hartshorn, 1982; Kogelman & Warren, 1978), while others believe the origin is more instinctive and a function of learning style or poor mathematics ability (Betz, 1978; Frary & Ling, 1983; Hadfield & Maddux, 1988). Tobias (1978) stated that there are those who believe that people experience mathematics anxiety because of inadequate mathematics preparation.

Other origins of mathematics anxiety are frequently referred to in mathematics anxiety literature and research. These origins will be discussed in three subsections titled *Mythical Origins*, *Miscellaneous Origins*, and *Instructional-Related Origins*.

**Mythical Origins**

*The American Heritage Dictionary of the English Language* (2000) defines myth as a fiction or half-truth – specifically one that forms part of an ideology. Certain myths often perpetuate mathematics anxiety. One myth about the origin of mathematics anxiety is that either a person has a mathematical mind or he does not have a mathematical mind (Tobias, 1978). Most people believe that "some people are math types" and some are not (Clawson, 1991, p. 4). Tobias (1978) questions whether one must have a mathematical mind to be successful mathematically. Yet, people believe that they have limited capabilities when it comes to learning mathematics, but generally do not feel this way about other subjects. If one believes he does not possess this mathematical mind, then he may believe that once a certain level is reached he will not be able to progress further.

Teachers can imply to students that they do not have a mathematical mind thereby increasing these students' levels of mathematics anxiety (Tobias, 1978).

The concept that "mathematics is taught as an exact science" and that there is an elusive "right" answer is another myth that perpetuates mathematics anxiety (Tobias, 1978, p. 64). While exact answers are important in reality, the "process" of obtaining the right answer is equally important. Tobias believes that "students of math should learn that the power of mathematics lies not only in exactness but in the processing of information" (p. 67). Others believe that "math is too precise" (Clawson, 1991, p. 4). Clawson (1991) believes that once the fundamentals of mathematics are understood, then people can "learn to make use of both precision and imprecision" (p. 4).

Another common myth believed to perpetuate mathematics anxiety is the idea that men are better at mathematics than women (Clawson, 1991; *Coping with Math Anxiety,* 2004; Tobias, 1978). This idea inhibits females in a number of ways. Tobias (1978) raises a number of questions about the performance of females in mathematics. Do females perform at a lower level in math because they think other people will think they are abnormal in some way? Have females been educated to believe they do not need mathematics in the same ways that males need mathematics? Are there teaching techniques that lend themselves to teaching females versus teaching males? All of these questions present situations that are believed to cause mathematics anxiety in females.

The gender effect has been a popular area of research since Tobias published her first edition of *Overcoming Math Anxiety* in 1978. Four years prior to publication of *Overcoming Math Anxiety,* Tobias first "hypothesized that mathematics anxiety and mathematics avoidance were feminist issues" (Tobias, 1993, p. 23). Yet, by 1978, she

determined after observing males "that some men as well as the majority of women have been denied the pleasures and the powers" that mathematics can provide (Tobias, 1993, p. 23).

Prior to the publishing of Tobias's *Overcoming Math Anxiety*, mathematics and science were accepted as male-dominated subjects with English and other liberal arts fields being accepted as female-dominated subjects. However, research varies as to exactly what effect gender has on levels of mathematics anxiety. Flessati and Jamieson (1991) found that it is more acceptable for females to express higher levels of mathematics anxiety than males even though females demonstrated superior mathematics proficiency in their study.

In another study, Hunsley and Flessati (1988) "pitted the 'sex-role' hypothesis against the 'math experience' hypothesis" to examine the relation between gender and mathematics anxiety (p. 215). One hundred seventy-one college students completed the original MARS. Hunsley and Flessati (1988) stated that the MARS was chosen because "it is the most psychometrically sound math anxiety instrument available" (p. 217). The students also completed a mathematics biography questionnaire. The researchers determined mathematics anxiety is not truly gender-related, "but rather is due to poor mathematical preparation, regardless of gender" (Hunsley & Flessati, 1988, p. 215).

Bernstein, Cote-Bonanno, and Reilly (1992) conducted a study utilizing a survey design with 1,152 students from 12 New Jersey school districts. The purpose of the study was "to examine the impact of math anxiety on students enrolled in single parent and nontraditional career preparation programs and to examine feelings of math anxiety as related to selected demographic characteristics" (p. 1). The study's findings indicated

that gender was "significantly related to math anxiety for students between the ages of fourteen and nineteen" (p. 5). Results demonstrated that before the age of fourteen, males and females bad similar feelings of mathematics anxiety, but at fourteen years, males sbowed significantly lower levels of mathematics anxiety. The researchers believe that "this finding indicates that programs to alleviate math anxiety need to begin in the elementary years" with career options requiring mathematics proficiency "presented as suitable for both males and females" (Bernstein et al., 1992, p. 5).

A National Education Association's 2000-2001 research report, *Status of the American Public School Teacher*, stated that a "much larger portion of the female teacber workforce worked at the elementary level than of the male teacher workforce (61% vs. 22%)" (p. 24). In addition, this report indicated that the percentage of male elementary teachers had fallen from an all-time high of 18 percent in 1981 to an all-time low of 9 percent in 2001. While the present study does not address gender-rclated issues, the majority of elementary school teachers are female and therefore any gender-related research is valuable to mathematics anxiety researcb involving elementary teachers.

**Miscellaneous Origins**

Some origins of mathematics anxiety are distinct and are not necessarily related to each other in any particular way except that they do perpetuate mathematics anxiety. One origin of mathematics involves the language of mathematics. Like all disciplines, mathematics has its own language. Unfortunately, the language of mathematics can be ambiguous and this ambiguity can cause mathematics anxiety (Tobias, 1993). In order to combat this ambiguity, one should practice mathematics language as one practices a

foreign language (Rosebush, n.d.). Words mean various things to a person depending on that person's experiences. Often, a student is taught to associate a particular meaning with a particular word, but later discovers other that meanings create confusion when the student is not sure of which meaning to use. Tobias (1993) provides an example using the word "multiply." In initial experiences with multiplication, it is often implied that when one number is multiplied by another number, the result is a larger number. This is not true in all cases. Confusion may arise for a student wben be begins multiplying fractions because the result may be a smaller number. Tobias (1993) states that a mind that is bothered by such ambiguities, whether actual or perceived, "is not usually a weak mind, but a strong one" (p. 56).

Tbe ambiguity in mathematical language often leads to another cause of mathematics anxiety – distrust of intuition (Tobias, 1978). This distrust often occurs if a student is not comfortable with a topic or bas not been successful with this topic before. In thcse types of situations, the student may not trust his intuition. If a math-anxious person thinks of an idea or strategy quickly, be can be prone to dismiss it hastily as wrong even in situations wben the student is correct (Tobias, 1978). A math-anxious student may often second-guess himself. This distrust of intuition appears to be a major difference in those wbo are successful in mathematics and tbose wbo are not.

Tobias (1978) identifies "self-defeating self-talk" as a cause of mathematics anxiety. Most think of self-talk as "talking to ourselves" (Tobias, 1978, p. 67). It is what one often says to himself wben be is in a difficult situation. A student may approach a problem and quit quickly. This behavior may be attributed to negative self-talk as much as it may be attributed to being unfamiliar with the mathematics of the problem.

Tohias (1978) describes an idea called "the dropped stitch" that refers to situations such as a student being absent the day fractions were introduced or a teacher heing absent for an extended period of time (p. 55). A student will use these situations to explain his failure in mathematics and, ultimately, his mathematics anxiety. Mathematics is a cumulative discipline and "a missing link can damage understanding much as a dropped stitch ruins a knitted sleeve" (Tohias, 1978, p. 55). Tobias states:

> But heing sick or in transit or just too far hehind to learn the next new idea is not reason enough for doing poorly at math forever after. It is unlikely that one missing link can abort the whole process of learning elementary arithmetic (p. 55).

Parental attitudes concerning mathematics can also contribute to children's mathematics anxiety (Tobias, 1993). If parents perform poorly in mathematics, they have bad their "own sudden death experience" and can also be victims of mathematics anxiety (Tobias, 1993, p. 53). Parents with mathematics anxiety can transfer that anxicty to their children (Fiore, 1999). Parents with negative attitudes can transfer tbese attitudes to their children and often reinforce the children's mathematics anxiety (Lazarus, 1974; Wilhelm & Brooks, 1980). If parents perform well in mathematics, they cannot relate to the feelings of a mathematics-anxious child who has difficulty with the subject. Whether weak or strong in mathematics, parents can promote the idea that either a person has a mathematical mind or he does not have a mathematical mind.

**Instructional-Related Origins**

Mathematics anxiety research indicates that mathematics anxiety is a learned response, which is more hehavioral than cognitive (Hemhree, 1990); researcb also indicates that mathematics anxiety can originate with the attitudes, hehavior, and teaching

techniques of teachers (Haralson, 2001; Jackson & Leffingwell, 1999; Norwood, 1994). Fiore (1999) strongly believes that "teachers and the teaching of mathematics are known to be the roots of mathematics anxiety" (p. 403). Additional research suggests that teachers can transfer mathematics anxiety to their students (Lazarus, 1974; Martinez, 1987; Sovchik, 1996; Wood, 1988). Kutner (1992) of the *New York Times* reported on a study indicating that teachers who are uncomfortable with mathematics can pass on feelings of mathematics anxiety to their students. The possibility of teachers passing on their own mathematics anxiety on to their students is consistent with the findings of Hembree's meta-analysis (Hembree, 1990). Specific instructional-related origins will be discussed further.

There are various teacher attitudes concerning mathematics and the teaching of mathematics that can affect the mathematics anxiety level of students. If a teacher is mathematically inclined and has "had an entirely happy history of learning mathematics," then he may convey the idea to the students that some students are mathematically gifted and some are not (Tobias, 1993, p. 53). This behavior perpetuates the myth about the origins of mathematics anxiety – a person has a mathematical mind or he does not have a mathematical mind (Tobias, 1978; Clawson, 1991).

If a mathematics teacher is not mathematically inclined, he may not be comfortable with the mathematics. A teacher can transfer feelings of math anxiety by demonstrating his own discomfort with mathematics in the classroom (Kutner, 1992). Teague and Austin-Martin (1981) conducted a study with 66 preservice elementary teachers. Students were enrolled in either a mathematics methods course or a children's literature course. Students in the mathematics methods course were randomly assigned to

an experimental group and a control group. The students in the literature course formed another control group. After five weeks in the course, the students in the experimental group began teaching a group of children twice a week. The study focused on the relationship of both mathematics and situational anxiety to teaching performance. The researchers found a positive correlation between teaching mathematics and feeling comfortable with the mathematics. Teague and Austin-Martin (1981) stated:

> It would be expected that teachers feeling comfortable with math, perbaps as a result of their own perceived conceptual or operational strength, would be able to move ahead more readily to strengthen other performance criteria areas (p. 8).

However, the researchers did not find a positive correlation between teaching mathematics and general mathematics anxiety. Teague and Austin-Martin (1981) indicated that this result "may be a function of the measure used" (p. 8). The mathcmatics anxiety instrument asked for responses relating to high school or college algebra and preservice teachers may not havc perceived that difficulty with algebra would hinder their teaching mathematics to children.

Martinez and Martinez (1996) contend that feelings of mathematics anxiety must be controlled in order not to influence students negatively. Jackson and Leffingwell (1999) implied that students tend to internalize a teacher's lack of enthusiasm for teaching and/or mathematics. If students believe a teacher is uncomfortable and unhappy in the classroom, they will be less motivated to learn.

If teachers are uncomfortable with mathematics, then the same teachers can have negative beliefs about mathematics. These negative beliefs often manifest in mathematics anxiety (Uusimaki & Nason, 2004). It has been suggested that teachers who have negative beliefs about mathematics produce a learned belplessness response from

students (Karp, 1991). Teachers' negative beliefs can be traced to experiences with uncaring teachers who falsely assume that computation is simple and needs no explanation (Cornell, 1999).

Martinez and Martinez (1996) related a story of "one spartan math teacher who views math as one of those unpleasant facts of life" and tells his students that they don't have to like math; they just have to do it (p. 15). This is an example of a math-anxious teacher who is probably not a good mathematics teacher and "unconsciously propagates negative attitudes about math learning" (Martinez & Martinez, 1996, p.15).

Authority is another issue in the relationship between teachers, students, and mathematics anxiety (Buxton, 1991). The teacher as an authority figure can pressure students even if the teacher does not consider himself a forceful figure (Buxton, 1991). "It does not matter that the person is not seen by him- or herself in this light; even the mildest of teachers may represent authority to some" (Buxton, 1991, p. 10). Students are "intimidated by officious and sometimes sexist teachers and others who may themselves suffer from math anxiety" (Paulos, 1998, p. 118).

Jackson and Leffingwell (1999) conducted a study during three semesters with 157 students enrolled in a senior-level mathematics content course required for elementary education certification. The researchers studied teachers' overt and covert behaviors that produced mathematics anxiety in students (Jackson & Leffingwell, 1999). Overt behaviors are observable. Overt behaviors producing mathematics anxiety in students included telling students that they should already know a concept and/or telling them that they do not perform as well as other students. Covert behaviors are implied, but are just as harmful as overt behaviors. Covert behaviors producing mathematics

anxiety in students included ignoring students and/or not making eye contact with students.

Researchers suggest that because mathematics learning is a function of mathematics teaching, then mathematics anxiety may be a function of mathematics teaching (Harper & Daane, 1998; Lazarus, 1974; Newstead, 1998; Peterson & Fennema, 1985; Skemp, 1979). In an editorial in the National Council of Teachers of Mathematics' *Arithmetic Teacher*, Greenwood (1984) stated that he believed the main cause of mathematics anxiety to be the teaching strategies used to teach basic mathematics skills. He claimed that the real origin of mathematics anxiety is in the specific teaching strategy in which the teacher explains, the students practice, and then students memorize the procedure. The emphasis is on memorization with no emphasis on understanding and reasoning. This particular strategy is often referred to as the traditional approach.

Newstead (1998) conducted a study with nine- to eleven-year-old students comparing the mathematics anxiety of students taught in a traditional or formal manner with that of students taught utilizing an alternative teaching approach. This approach focused on problem solving and the discussion of student-developed non-traditional or informal techniques. One of the findings of this study is that students who were taught using a traditional approach reported higher levels of mathematics anxiety than those who were taught using the alternative approach, specifically with respect to the social and public facets of "doing mathematics." The researcher did raise the question of whether it is "these public aspects of doing mathematics in the presence of teachers and peers which

actually evoke mathematics anxiety in many pupils, and not working with numbers or doing sums" (Newstead, 1998, p. 53).

Harper and Daane (1998) conducted a study analyzing the mathematics anxiety levels of 53 preservice teachers before and after a mathematics methods course. The original Mathematics Anxiety Rating Scale (MARS) was used to measure the students' levels of mathematics anxiety. Forty-four of the students showed a reduction in mathematics anxiety with nine showing an increase. Eleven students showing the greatest differences in mathematics anxiety levels were chosen to participate further with six showing a decrease and five showing an increase. Utilizing questionnaires, interviews, and self-reflections, the researchers determined that the factors having a negative effect on the students' mathematics anxiety included lecture-style instruction, timed tests, and drill-type skill practice – all of which are considered part of formal or traditional instruction. This study linked the origin of mathematics anxiety to experiences with formal mathematics instruction at the elementary and secondary levels. Harper and Daane (1998) stated:

> These experiences have tended to lower confidence in one's mathematical ability which has led to mathematics avoidance by the time the student was in secondary school. Thus, the elementary mathematics classroom might be considered as a beginning point for creating mathematics anxiety (p. 29).

Oberlin (1982) stated that there are various teaching techniques that can cause mathematics anxiety – assigning identical problems for all students, following the textbook problem by problem, assigning written work every day, insisting on one way to solve a problem, and assigning mathematics homework as a punishment for misbehaving.

Arem (1993) found one elementary school teacher who actually told his class that if they were good all day, then they would not have to do any mathematics that day.

## Effects of Mathematics Anxiety

Reys et al., (2007) state, "Children attempting to memorize mathematics without understanding are likely to fall into the 'anxiety gorge'" of mathematics anxiety or mathophobia (p. 18). While in that gorge, students experience effects of mathematics anxiety – misunderstandings, poor performance on math tests, uncertainty, apathy, lack of confidence, dislike of mathematics, low motivation, and classroom behavior problems. Each of these or a combination of these can affect the mathematics anxiety victim's life as a student and as an adult "with far-reaching consequences" (Newstead, 1998, p. 53).

As early as the 1950's, determining causes or origins of mathematics anxiety have been unsuccessful (Gough, 1954); since the 1970's numerous researchers have reported the effects or consequences of being mathematically anxious. These effects or consequences include avoiding mathematics courses, limiting one's selection of college and career choice, declining mathematics achievement, and feeling guilty or ashamed about mathematics (Armstrong, 1985; Betz, 1978; Brush, 1978; Burton, 1979; Donady & Tobias, 1977; Hendel, 1980, Preston, 1987; Richardson & Suinn, 1972; Tobias & Weissbrod, 1980). The National Research Council (1989) stated that not only are there significant professional and economic gains that can result from converting mathematics anxiety into mathematics confidence, but the psychological lift that individuals can experience when successful in mathematics is also significant. Some of the effects or consequences will be discussed in further detail.

As stated, one effect of mathematics anxiety is avoidance of mathematics (Hembree, 1990). When mathematics anxiety victims are affected "to the point of being untenable, avoidance of further exposure to mathematics becomes the solution in the vast majority of cases" (Furner & Berman, 2004, p. 16). If mathematics anxiety victims avoid mathematics, then they essentially eliminate numerous career opportunities because so many college majors require advanced mathematics (Segeler, 1987). In addition, if the mathematics anxiety victim is a preservice teacher, the mathematics anxiety may stop the preservice teacher from acquiring the mathematics content, skills, and processes necessary to teach students (Tishler, 1980).

California sociologist, Lucy Sells, referred to mathematics as a "critical filter," meaning that victims of mathematics anxiety are filtered away from careers requiring college mathematics (Zaslavsky, 1994). In a study conducted by Richardson and Suinn (1972), many of the volunteers for mathematics anxiety treatment were graduate students having trouble with the small number of mathematics formulas necessary in their fields of study ranging from business to zoology.

As Reys et al., (2007) indicated in their description of the "anxiety gorge," one of the effects of mathematics anxiety is a lack of motivation in the area of mathematics. A study of the Commitment and Necessary Effort (CANE) model of motivation when applied to mathematics, and including mathematics anxiety as a variable influencing mathematical persistence, determined that mathematics anxiety had a larger effect on mathematical persistence than other variables of mathematical self-efficacy or mathematics task value (Reynolds, 2003). Motivation is of great interest to mathematics

educators and various methods for motivating students are discussed in this study's literature review section *Reducing and Preventing Mathematics Anxiety.*

Numerous studies have been conducted to investigate the relationship hetween mathematics anxiety and mathematics achievement. In a meta-analysis of 26 studies involving fourth through twelfth grade students, Ma (1999) examined this relationship between mathematics anxiety and mathematics achievement. The researcher used a three-step approach to locate relevant studies. First, using key words of "mathematics," "achievement," and "anxiety," he searched four data bases – Educational Resources Information Center (ERIC), Psychological Abstracts, Dissertation Ahstracts International, and International ERIC, which includes resources from Australia, Great Britain, and Canada. Criteria for selection of studies included investigation of a relationship between mathematics anxiety and achicvement, participation of clementary and/or secondary students, and quantitative data involving sufficient information for calculating effcct size.

Ma (1999) found that the common population correlation for the relationship at -.27 was statistically significant at the .01 level. The researcher utilized a series of general linear models, which demonstrated that the relationship is consistent across gender groups, grade-level groups, ethnic groups, instruments measuring anxiety, and years of the studies' publications. The relationship did indicate a statistically significant difference among achievement instruments. Researchers utilizing standardized achievement tests tended to report "a relationship of significantly smaller magnitude than researchers using mathematics' teachers' grades and researcher-made achievement tests" (Ma, 1999, p. 520). In examining theoretical and practical implications, Ma concluded the meta-analysis did support the findings of a statistically significant relationship

between mathematics anxiety and mathematics achievement for school students as reported by other researchers such as Armstrong (1985), Hackett (1985), and Wigfield and Meece (1988).

Some researchers (Ashcraft, 2002; Ashcraft & Faust, 1988; Ashcraft & Kirk, 2001; Faust, Ashcraft, & Fleck, 1996) have studied the cognitive aspects of mathematics anxiety. It appears that Ashcraft and his colleagues were the first researchers to ask whether mathematics anxiety affected mental processes during problem solving. Ashcraft and his team of researchers conducted a study with college students. The college students completed the original Mathematics Anxiety Rating Scale (MARS). They were then asked to take several elementary arithmetic problems tests involving addition and subtraction of whole numbers. Error data and reaction time were used as cognitive processing measures. Students classified as mathematically anxious, based on the MARS scores, were found to have a statistically significant disadvantage in speed of processing and accuracy of results. In addition, these individuals demonstrated shorter working memory spans.

Brady and Bowd (2005) stated, "[M]athematics anxiety has a multifaceted impact on mathematics education" (p. 39). One obvious impact is that it affects students' performance. Surveys of anxiety research indicate that higher levels of anxiety can affect performance (Betz, 1978; Buckley & Ribody, 1982; Clute, 1984; Rounds & Hendel, 1980). Further research has indicated that mathematics anxiety contributes to lower performance levels on standardized tests and lower grades in mathematics courses (Meece, Wigfield, & Eccles, 1990).

Bush (1989) conducted a study to determine if a statistically significant relationship exists between math-anxious teachers and their teaching practices. The study's subjects were 31 fourth, fifth, and sixth grade teachers and their students from six suburban elementary schools in a Kentucky metropolitan school district. Upper elementary teachers were selected based on the following:

> (1) high incidences of mathematics anxiety have been found in elementary education majors (Bulmahn & Young, 1982; Kelly & Tomhave, 1985; Sovchik, Meconi, & Steiner, 1981) and
> (2) mathematics anxiety is more easily measured in upper elementary students than in younger children (Bush, 1989, p. 500).

The study's results yielded few statistically significant relationships between teacher mathematics anxiety and teaching practices (Bush, 1989). As a whole, math-anxious teachers' teaching strategies did not differ drastically from non-math anxious teachers. However, the study did indicate that math-anxious teachers tend to use more traditional teaching methods than non-traditional methods. These non-traditional methods include games, problem solving, and individualized or small-group instruction. It was also determined in Bush's study that math-anxious teachers were more likely to teach skills rather than concepts. The National Council of Teachers of Mathematics (NCTM) recommends these same non-traditional methods to reduce mathematics anxiety and advocates the teaching of understanding concepts in addition to skills. It is important to note that the NCTM's *Principles and Standards for School Mathematics* was first published in 1989 – the same year that the results of Bush's study were published.

## Reduction and Prevention of Mathematics Anxiety

Hogben, an English zoologist and geneticist, once commented (as cited in

Tohias, 1978):

> The hest therapy for emotional hlocks to math is the realization that the human race took centuries or millennia to see through the mist of difficulties and paradoxes which instructors now invite us to solve in a few minutes (p. 235).

The first step in reducing mathematics anxiety is realizing that mathematics is a process that has evolved over time and no one is expected to solve prohlems immediately. This step leads to the realization that one is not alone and there are others who suffer from mathematics anxiety. Once a person faces this reality and wants to confront this anxiety, he should seek help (Tobias, 1978).

Seeking help can involve professionals (Tobias, 1978). A common method of obtaining help is through group desensitization, which research suggests is highly successful in reduction of mathematics anxiety (Hembree, 1990). Group desensitization usually involves thrcc phascs (Schunk, 2004). In the first phase, the mathematics anxiety victim develops a hierarchy of situations that are origins of mathematics anxicty and then ranks the situations from those that produce the least anxiety to those which produce the most anxiety. In the second phase, the person being treated is asked to develop methods of relaxation. The third phase involves associating the relaxation techniques acquired in phase two with those situations in phase one. Obviously, this process takes time and commitment. The process can involve a leader such as a psychologist and may involve a math instructor. The two act as a team to help the members of the desensitization group "eliminate anxiety-producing experiences" such as not having tests, no pressure for correct answers, no competition with other students, and no "put-downs" (Tohias, 1993, p. 233). If the "usual mathematics experience" is reversed and the learner is given one positive mathematics experience, then this "will go far toward reducing anxiety" (Tohias,

1993, p. 233). This is substantiated in Hembree's 1990 meta-analysis results that indicate students with positive attitudes showed consistently lower measures of mathematics anxiety.

A mathematics anxiety victim often tries to avoid anything to do with math including talking about it (Tobias, 1978). There are math clinics that provide specialized learning situations for math-anxious people. These clinics are designed to "integrate talking about math into the learning process" (Tobias, 1978, p. 247). Tobias believes that talking about mathematics is the key to the treatment of mathematics anxiety. Talking about mathematics helps some to realize that they are not the only people who are afraid of mathematics or feel inadequate about "doing math." Discussion can remove the obstacles of learning by providing insight into what is obstructing the learning. This discussion can be held with a therapist in groups or individually. While this is recommended by Tobias, Hembree (1990) found that the "cognitive treatment of group discussion" was not effective (p. 43).

Another method of reducing mathematics anxiety is immersion (Tobias, 1978). As stated earlier, some believe that math anxiety is caused simply by a lack of mathematics preparation. If this is the case, then one should begin studying math again at the appropriate level. This method itself can cause anxiety, but one should realize that as an adult, the mental processes are much more advanced and concepts taught possibly at middle school level will be easier to grasp as an adult learner (Tobias, 1978). Also, an adult learner who is self-efficacious will monitor his learning progress and be motivated to exert the effort to reach his academic goals (Schunk, 2004).

In addition to professional help from psychologists and mathematics teachers, the mathematics anxiety victim can take his treatment into his own hands. When someone wants to improve a skill such as playing tennis or singing, it is natural for that person to practice on a regular basis. It is the same for the math-anxious person who wants to increase his mathematical ability and eliminate the anxiety. Tobias (1978) suggests three areas of practice - spatial skills, number play, and puzzle solving. Many commercial products offer figure problems, number games, and mathematical puzzles. In addition, a student can use a visual approach with mathematical manipulatives. These manipulatives can include physical items such as pattern blocks, fraction bars, and base ten blocks, but may also include computer simulations and games (Vinson, Haynes, Sloan, & Gresham, 1997). Seymour (1996) interviewed teachers and found that using manipulatives and real-life mathematical events helped students to understand mathematics.

Jackson and Leffingwell (1999) conducted a study over three semesters with 157 students enrolled in a senior-level mathematics content course required for elementary education certification. Students responded to a prompt – 'Describe your worst or most challenging mathematics classroom experience from kindergarten through college' (Jackson & Leffingwell, 1999, p. 583). Based upon student responses, the researchers recommend that teachers disclose their own mathematics anxiety and that they share experiences of how they worked through their own mathematics anxiety in an effort to motivate students to work through or past the anxiety. Tobias (1978) states that if a teacher appears to always be able to do mathematics easily, then he may create an illusion that some people are able to do math easily and some are not. A simple way to change the illusion is for a teacher to bring in some work showing the student that even he had to

work through many steps and had to try many different things before actually solving the problem.

Tooke and Lindstrom (1998) studied the effectiveness of a mathematics methods course in reducing mathematics anxiety of preservice elementary teachers. The researchers examined three cases – one mathematics content course taught in a traditional manner, one mathematics content course taught in a nontraditional manner consistent with NCTM's recommendations, and two sections of a mathematics methods course covering similar content and addressing the pedagogy. There were approximately 120 participants. Each participant was administered the Mathematics Anxiety Rating Scale (MARS) prior to and after the course. Results suggested that "students' mathematics anxiety may be reduced by completing a mathematics methodology course," but no evidence was produced that students' mathematics anxiety may be reduced by completing a mathematics content course (Tooke & Lindstrom, 1998, p. 135). Participating students "who felt their anxiety was reduced by completing either course" were asked what they believed contributed to their decrease in mathematics anxiety (Tooke & Lindstrom, 1998, p. 135). Some participants from all sections indicated 'clarity of instruction' and/or 'relevance to their career.' Some students from one mathematics section and both methods sections mentioned 'nontraditional activities' as reducing their anxiety. While there was a statistically significant reduction of mathematics anxiety in the methods course, but not in the content courses, all of the participants' comments were associated with both courses, not just the methods course.

John Van de Walle (1972) conducted a study involving third-grade and sixth-grade teachers by examining their formal and informal perceptions of math. A formal

perception involves a math emphasis on rote memory and drill while an informal perception involves a math emphasis on probing questions and trial-and-error. Data were gathered initially from a small group of elementary teachers and used in the development of an instrument "intended to measure one's perception of elementary mathematics along an informal-formal continuum" (Van de Walle, 1972, p. 3). This instrument was administered to 66 third grade teachers and 56 sixth grade teachers. Findings indicated that when a teacher had an informal perception, the effects were positive on the students, such as having low math anxiety. The informal method emphasizes understanding, which appeared to reduce math anxiety.

D.E. Cruikshank and L.J. Sheffield (as cited in Vinson, et al., 1997) stated that they were not convinced that a primary grade student might actually suffer from math anxiety. They believed that if certain teaching techniques were not used, teachers could "cause their students to learn math-anxious behaviors" (Vinson, et al., 1997, p. 3). These teaching techniques included the teacher displaying to his students that he actually likes mathematics. The teacher should make mathematics enjoyable and show its use in everyday situations. The topics should be adapted to the interest of the students and should include meaningful teaching methods so that the mathematics made sense to the students. The teacher and the students should make short-term goals that are attainable. However, Newstead (1998) stated that the data collected in her study of nine- and eleven-year olds did "provide evidence to support the assertion mathematics anxiety is a phenomenon which *begins at an early age*" (p. 66).

Reys et al., (2007) suggest a number of ways teachers can help students cope with mathematics anxiety and thereby reduce the anxiety. Teachers should focus on

understanding as opposed to memorization. Elementary students do not readily learn isolated facts, illogical things, or things with no meaning (Caine & Caine, 1994). Reys et al., (2007) described mathematics anxiety and mathematics phobia as an anxiety gorge separating the "concrete" from the "abstract." Students "attempting to memorize mathematics without understanding are likely to fall into this 'anxiety gorge'" (Reys et al., 2007, p. 18). Teachers must assist students in making the connections between the concrete and the abstract in order to facilitate understanding, to advance success at learning, and to relieve mathematics anxiety symptoms.

School principals should be instrumental in implementing best practices for teaching mathematics utilizing techniques that can help students reduce mathematics anxiety. Zemelman, Daniels, and Hyde (1998) suggested that principals educate faculty about the *National Council of Teachers of Mathematics Standards* in addition to local and state standards. Parents can be educated through events such as Family Math Nights. Schools' budgets should provide funds for professional development. Principals should encourage use of manipulatives in the classroom and a wide variety of assessment techniques. Teachers should be encouraged to form networks to share information about methods that work in the classroom regarding mathematics content and mathematics anxiety.

The National Council of Teachers of Mathematics (1995a) suggests a number of ways in which teachers can prevent mathematics anxiety. Some are similar to techniques suggested by research studies. They are as follows:

1) Accommodate different styles of learning;

2) Create a variety of testing environments;

3) Design positive experiences in mathematics classes;

4) Emphasize that mathematical ability is not a measure of self-worth;

5) Emphasize that everyone makes mistakes in mathematics;

6) Make mathematics relevant to life;

7) Allow students input into their own evaluations;

8) Allow for different social approaches to learning mathematics;

9) Encourage original thinking instead of rote memorization;

10) Characterize mathematics as a human endeavor.

Mathematics anxiety research indicates that when measures are taken to prevent and reduce mathematics anxiety, the level of mathematics anxiety decreases (Hembree, 1990). Desper (1988) concluded that prevention of mathematics anxiety starts with teachers who use teaching techniques building positive self-concepts. Reys et al., (2007) state, "[T]he best strategy is prevention, and the second best is early detection" followed by specific actions as described in this section of the literature review (p. 19).

## Development of the Mathematics Anxiety Rating Scale

One of the first instruments developed to measure mathematics anxiety was the Mathematics Anxiety Rating Scale, commonly referred to as the MARS (Richardson & Suinn, 1972). Suinn and Richardson (1972) developed the MARS in the early 1970's. The two researchers defined mathematics anxiety as "feelings of tension and anxiety that interfere with the manipulation of numbers and the solving of ordinary life and academic situations" (Richardson & Suinn, 1972, p. 551). This definition would serve as their framework when developing the MARS. Prior to this instrument, there were instruments

that measured single types of anxiety such as test-taking anxiety or social anxiety but nothing that specifically measured mathematics anxiety. Dreger and Aiken (1957) had developed a tool to measure what they referred to as "numher anxiety" (p. 344). Suinn (1970) reported that in a university counseling center hehavior therapy program, it was demonstrated that individuals had mathematics anxiety but did not necessarily have other anxieties. Richardson and Suinn (1972) "found that a numher of volunteers for mathematics anxiety treatment are graduate students who have difficulty with the relatively small hut significant numher of mathematical formulations in their area of specialization, such as zoology or business" (p. 551).

Richardson and Suinn (1972) believed that a reliable measure of mathematics anxiety would be useful in a variety of ways. Mathematics anxiety is common among college students (Hembree, 1990). A diagnostic tool would be meaningful and could be used in research to measure thc effectivcness of different types of mathematics anxiety treatments. If a person were diagnosed with mathematics anxiety and chose a desensitization program, the instrument itself could be used to create the anxiety hierarchy. They also believed that "normative data on changes in test scores occurring without treatment would prove useful in evaluation of the results of studies where a control group is lacking and in evaluating the progress of individual clinical cases" (Richardson & Suinn, 1972, p. 552).

The Mathematics Anxiety Rating Scale is a self-rating scale of 98 mathematics situational items (Weinberg, 1992). Various types of items were included to relate to different clients such as students and nonstudents (Richardson & Suinn, 1972). Each situational item requires the student to rate his anxiety level score of 1 to 5, with 1

representing "not at all anxious" to 5 representing "very much anxious." The individual item scores are added together to determine an overall mathematics anxiety score. Scores can range from a low of 98 to a high of 490. The score of 98 would indicate low anxiety with the score of 490 indicating extreme anxiety (Richardson & Suinn, 1972).

In *The Mathematics Anxiety Rating Scale: Psychometric Data,* Richardson and Suinn (1972) reported on the normative, reliability, and validity data gathered on the MARS. University students from Missouri and Colorado were used to generate the data. A sample of 397 students enrolled in a large Missouri state university was used to collect the normative data. These students were freshmen or sophomores enrolled in beginning education classes. Approximately 80 percent of the students were females, "but analysis of the data showed no significant difference between the mean scores or standard deviations for males and females" (Richardson & Suinn, 1972, p. 552). In order to encourage cooperation and to control a possible threat to validity, students were assured that the results of the testing were not to determine information about them individually, but to obtain information about the test itself. Normative data results from this Missouri sample included a mean score of 215.38 with a standard deviation of 65.29.

The results of the study confirmed that the test scores were "highly reliable" and "that the test items are heavily dominated by a single homogeneous factor, presumably mathematics anxiety" (Richardson & Suinn, 1972, p. 553). In order to determine score reliability, two complete classes of 35 students from the original Missouri sample were retested seven weeks later to determine a test-retest reliability coefficient for scores on the MARS. The first test with these groups resulted in a mean score of 235.08 with a standard deviation of 51.26. The second test resulted in a mean score of 232.97 with a

standard deviation of 56.46. Richardson and Suinn (1972) calculated the Pearson product-moment coefficient hetween the two sets of test scores to he .85. Comparing this reliability with other measures of reliability over short time spans was favorahle. Watson and Friend (as cited in Ricbardson & Suinn, 1972) reported reliability coefficients of .78 and .68 for social anxiety measures. Suinn (1968) reported a reliability coefficient of .80 for the Taylor Manifest Anxiety Scale. In addition, an internal consistency reliability coefficient was calculated at .97 with the sample population of 397 indicating "the average intercorrelation of the items in the test is high" (Richardson & Suinn, 1972, p. 553). The researchers also calculated item-total correlations for each item and "over half of the correlations were greater than .50" (Ricbardson & Suinn, 1972, p. 553).

Two types of information were used to determine validity of the scores on the MARS. First, three studies conducted in the early 1970's showed that scores on the MARS decreased aftcr behavior therapy for mathematics anxiety (Richardson & Suinn, 1972). In each case, the change was statistically significant. For example, in one study involving ten Missouri students, the pre-therapy mean score was 238.73 with a post-therapy mean score of 179.12. With the assumption that these treatment programs did decrease the mathematics anxiety level, the corresponding decrease in the MARS scores was "viewed as providing construct validity for the test" (Richardson & Suinn, 1972, p. 553). The second source showing validity came from data collected in another Missouri study. Thirty junior and senior students from an advanced undergraduate psychology class were given the MARS followed by the mathematics portion of the Differential Aptitude Test consisting of math problems ranging from simple to complex. Fifty percent of the students were female and 50 percent were male. Results of the two

tests were examined and the Pearson product-moment correlation between the students' scores on the two tests was -.64 with $p < .01$ indicating that poor performance on the mathematics test was associated with high MARS scores. Richardson and Suinn (1972) deduced that "since high anxiety interferes with performance, and poor performance produces anxiety, this result provides evidence that MARS does measure mathematics anxiety" (p. 553).

In concluding the discussion of the study, Richardson and Suinn (1972) stated that the MARS is a scale for mathematics anxiety that can be used in treatment or research. They assured psychologists "that any significant reduction in MARS scores following a treatment intervention is not due to the effects of retesting with the same instrument or the influence of intervening events" based on their study's test-retest reliability results (Richardson & Suinn, 1972, p. 553).

Richardson and Suinn described their instrument as unidimensional, but other researchers questioned this during the 1980's (Rounds & Hendel, 1980; Plake & Parker, 1982; Resnick, Viehe, & Segal, 1982; Alexander & Cobb, 1987). Rounds and Hendel (1980) conducted a factor analysis of the MARS, which showed two main factors interpreted as "Mathematics Test Anxiety" and "Numerical Anxiety" (p. 141). The Mathematics Test Anxiety items were related to "learning, studying, or being tested over mathematics from a classwork perspective" while the Numerical Anxiety items "dealt more with the day-to-day use of mathematical and computational concepts" (Plake & Parker, 1982, p. 552). Another study by Alexander and Cobb (1987) supported Rounds and Hendel's work. In both studies, "the Mathematics Test Anxiety dimension stood out as the primary dimension, whereas a Number Anxiety dimension appeared only as a

secondary dimension" (Alexander & Martray, 1989, p. 143). Research has indicated that the MARS is a multidimensional measure emphasizing mathematics test anxiety and numerical anxiety (Alexander & Martray, 1989, Plake & Parker, 1982; Resnick, Viehe, & Segal, 1982; Rounds & Hendel, 1980). Beyond this concept of multidimensionality, other questions have been raised about practitioners using the scale to identify mathematics anxious students easily and quickly (Alexander & Martray, 1989). One such question involved the length of the test – 98 items.

Three different pairs of researchers (Rounds & Hendel, 1980; Plake & Parker, 1982; Alexander & Martray, 1989) and eventually Suinn and another colleague, Winston, (2003) created shorter versions of the test. Each of the shortened versions of the MARS had positive features, as well as negative features. For example, only female subjects were used in the Rounds and Hendel study. Rounds and Hendel (1980) also failed to show a clear relationship between the two scales created by the other pairs of researchers: Alexander and Martray, Plake and Parker (Rounds & Hendel, 1980). Alexander and Martray's abbreviated version's main component was math test anxiety, while the main component of Plake and Parker's revised version was learning mathematics anxiety (Alexander & Martray, 1989). The sample for Alexander and Martray's abbreviated version was more representative of a general population of undergraduate university students while the sample for Plake and Parker's revised version was more representative of upper level undergraduate and graduate university students. Alexander and Martray (1989) concluded that their abbreviated version would be more suitable for the general student population because of its main construct – math test anxiety, which "has been

identified consistently as the major component of math anxiety in previous studies" (p. 149).

Suinn and Winston (2003) addressed this issue of length by creating another 30-item version of the MARS. It was noted that although all three of the previous shorter versions have promise, each had difficulties as mentioned previously. The purpose of Suinn and Winston's study was to systematically develop a brief version of the Mathematics Anxiety Rating Scale because the other brief versions lacked a representative sample. Suinn and Winston (2003) used 124 volunteers for this study consisting of 63 females and 61 males. All were students in an introductory psychology course from a state university representing a wide range of majors such as Occupational Therapy, Engineering, and Animal Science. Participants were given the original MARS, a revised 30-item MARS, and a demographic questionnaire. This questionnaire asked for information such as age, high school, and college mathematics courses taken, and college major; these "answers formed some of the data for validation of the 30-item scale" (Suinn & Winston, 2003, p. 170).

The revised 30-item MARS was created using three factor analytic studies of the original MARS – Alexander and Cobb (1987), Alexander and Martray (1989), and Rounds and Hendel (1980). As indicated previously, Rounds and Hendel (1980) identified two main factors of "Mathematics Test Anxiety" and "Numerical Anxiety" (p. 141). These factors represented "the core dimensions measured by the MARS" (Suinn & Winston, 2003, p. 169). Two criteria were used to select the 30 items – an item either was "an important factor" in at least two of the studies, or showed "the highest factor loading among factors in at least one of the studies" (Suinn & Winston, 2003,

p. 169).

The study's results showed the 30-item MARS to have high internal consistency with a Cronbach alpha of .96 (Suinn & Winston, 2003). This is consistent with the rating of .97 for the original MARS (Richardson & Suinn, 1972). Test-retest reliability after one week for the new version was .90 ($p < .001$), "which is equivalent to the test-retest reliability of .91 ($p < .001$) of the longer MARS 98-items obtained during this study" (Suinn & Winston, 2003, p. 170). Validity of scores for the new version was measured by determining the Pearson correlation r with the older version. For the first test of the test-retest reliability, r was .92 ($p < .001$) between the two versions and r was .94 ($p < .001$) for the second test of the test-retest (Suinn & Winston, 2003).

Suinn and Winston (2003) confirmed that the 30-item MARS "has acceptable reliabilities and validity comparable to the original MARS" (p. 171). However, the researchers did say that normative data were not obtained and would be needed if this new briefer MARS is to be used for diagnostic purposes. It was suggested that researchers use the original version if they want to rely on the studies published earlier on the 98-item MARS. Suinn and Winston (2003) concluded by saying that the 30-item MARS appears to be "a reasonable version for studies in which a briefer version is needed" such as when different tests are being administered or when testing time is minimal (p. 171).

## Summary

It is imperative that teachers of all levels consider their effect on students in reference to mathematics anxiety. Since the first occurrences of mathematics anxiety

have been traced to elementary school, elementary teachers should be prepared to provide positive mathematical experiences that prevent or reduce mathematics anxiety. In order to prepare elementary teachers, mathematics instructors of preservice elementary teachers should be aware of what they can do in order to reduce mathematics anxiety. If preservice teachers enter the teaching ranks with lower levels of mathematics anxiety, then it is logical that fewer elementary students will experience mathematics anxiety.

# CHAPTER III

# METHODOLOGY

The purpose of this study was to identify factors perceived by preservice elementary teachers as having reduced their mathematics anxiety while enrolled in a mathematics content course required for elementary education majors.

This chapter includes a description of the setting, a description of the participants, and a discussion of the data-collection instrumentation. The design of the study, along with the data collection and analysis procedures, is also included.

## Description of the Setting

The setting for the study was a large public higher education institution located in the south central portion of the United States. The institution is a Level VI institution accredited by the Southern Association of Colleges and Schools. The student population exceeds 30,000 – including more than 1,600 international students and approximately 5,000 graduate students. This university includes nine senior colleges and four schools, in addition to specialized centers, divisions, institutes, and offices. There are more than 1,200 full-time faculty members with a staff of 3000. Approximately 170 elementary education majors graduate from this institution each year.

## Description of the Participants

During the spring 2006 semester, students enrolled in 10 different sections of four different mathematics content undergraduate courses, required for elementary education majors, completed the Mathematics Anxiety Rating Scale-Short Version (MARS-SV) at the beginning and at the conclusion of the semester. Four different, experienced instructors taught these 10 sections. Each course section had a maximum enrollment of 30 students. The initial MARS-SV results served as pre-test and the final MARS-SV results served as post-test. Pre- and post-test results were compared for all students from the 10 different sections.

It was anticipated that the participants would be majority female, since the students in the targeted courses are mostly female – approximately 60 females to one male. All participants were female. The students' ages ranged from 18 to 39 years old, with the majority of the students being 19 or 20 years old. Specific demographics for all participants are provided in Chapter IV. All students were elementary education majors at the time the survey was conducted. One student has since changed majors. Thus, the sample consisted primarily of elementary education majors – those who have chosen to concentrate at the pre-K through third grade level, or the first through sixth grade level.

The 40 students who showed the greatest reduction in mathematics anxiety on the MARS-SV were invited to participate in the interview phase of the study through an electronic mail (e-mail) invitation. Specifically, these students were asked to be interviewed, individually, about the factors that each perceived as having reduced their mathematics anxiety while enrolled in a required mathematics content course for elementary education majors. It was initially proposed that of those who consented to be

interviewed, 15 students would be chosen randomly. However, only ten students responded to the invitation. Subsequently, the remaining 30 students were assigned numbers from one through 30 and a random number generator program was used to select 15 of these students to be invited by a phone call. The researcher placed phone calls to students in the order of the random selection and invited each student to participate until five more students consented. Interviews were scheduled and conducted with these 15 students. Subsequently, the 15 students completed two follow-up e-mail questionnaires.

In addition, the 40 students who showed the greatest increase in mathematics anxiety on the MARS-SV were asked to complete an e-mail questionnaire. Specifically, these students were asked about the factors that each perceived as having increased their mathematics anxiety while enrolled in a mathematics content course for elementary education majors. Thirteen students responded to the e-mail invitation and completed the initial e-mail questionnaire and one follow-up e-mail questionnaire.

## Research Question

The research question for this study is as follows:

> What factors do preservice elementary teachers perceive as having reduced their mathematics anxiety while they were enrolled in a required mathematics content course?

## Instrumentation

Six instruments were used to collect data for this study – two of which were used in the initial collection of data in order to identify students who had a change in

mathematics anxiety. First, each student answered a demographic questionnaire (See Appendix A) at the beginning of the semester. Second, the Mathematics Anxiety Rating Scale – Short Version was used to measure the level of mathematics anxiety in the preservice elementary teachers at the beginning of the spring semester and the end of the spring semester.

The third instrument was a semi-structured interview (See Appendix A). Fifteen of the 40 students who showed the greatest reduction in mathematics were interviewed. Interviews were used to collect the primary data for this dissertation study. The interview questions, developed by the researcher, were used to obtain the perceptions of the preservice teachers regarding factors that reduce mathematics anxiety while completing a mathematics content course designed and required for preservice elementary teachers.

The fourth instrument used was an e-mail questionnaire and is referred to as E-mail Questionnaire 1 (See Appendix A). This questionnaire was sent to the 15 participants following the interviews and consisted of three questions. The e-mail questionnaire responses were used to substantiate interview responses.

The fifth instrument used was an e-mail questionnaire and is referred to as E-mail Questionnaire 2 (See Appendix A). This questionnaire, consisting of five questions, was sent to the 40 participants who showed the greatest increase in mathematics anxiety while enrolled in a mathematics content course designed for preservice elementary teachers. Thirteen students completed and returned the e-mail questionnaire.

The sixth instrument used was also an e-mail questionnaire and is referred to as E-mail Questionnaire 3 (See Appendix A). The questionnaire was sent to 28 students – the 15 students who completed the individual interviews and the 13 students who responded

to the previously described e-mail questionnaire. This e-mail questionnaire consisted of one question. Each instrument is described in the following sections.

**Student Demographic Data Form**

Prior to responding to the initial MARS-SV, students were asked to first complete a demographic data form in order to provide background information of age, sex, and previous college mathematics courses. At the interview phase, each participant whose mathematics anxiety reduced, was asked to verify the demographic information. The students whose mathematics anxiety increased were asked to verify the demographic information in an e-mail questionnaire. This information was used to provide a description of the participants individually and collectively. A copy of the demographic data form is included in Appendix A.

**Mathematics Anxiety Rating Scale – Short Version**

The Mathematics Anxiety Rating Scale – Short Version (MARS-SV) is a revised 30-item version of the original 98-item Mathematics Anxiety Rating Scale (MARS) (Suinn & Winston, 2003). The revised 30-item MARS consists of brief descriptions of mathematical and non-mathematical situations. Participants are to rate each situation using a Likert-like scale of 1 to 5 with "1" being *not at all anxious* and "5" being *very anxious.*

The 30-item MARS-SV was shown to have high internal consistency with a Cronbach alpha of .96 (Suinn & Winston, 2003). These results are consistent with the rating of .97 for the original MARS (Richardson & Suinn, 1972). Test-retest reliability

after one week for the new version was .90 ($p < .001$), "which is equivalent to the test-retest reliability of .91 ($p < .001$) of the longer MARS 98-items obtained during this study" (Suinn & Winston, 2003, p. 170). Validity for the scores on the new version was measured by determining the Pearson correlations with the older version. For the first test of the test-retest reliability, r was .92 ($p < .001$) between the two versions, and r was .94 ($p < .001$) for the second test of the test-retest (Suinn & Winston, 2003).

Suinn and Winston (2003) confirmed that the 30-item MARS "has acceptable reliabilities and validity comparable to the original MARS" (p. 171). However, the researchers did say that normative data were not obtained and would be needed if this new briefer MARS is to be used for diagnostic purposes. It was suggested that researchers use the original version if they want to rely on the studies published earlier on the 98-item MARS. Suinn and Winston (2003) concluded by saying that they believe the 30-item MARS appears to be "a reasonable version for studies in which a briefer version is needed" such as when different tests are being administered or when testing time is minimal (p. 171). Since the MARS-SV is a copyrighted instrument, a copy is not included in the Appendix.

**Interview Protocol**

Upon examination of the MARS-SV pre- and post-test results, 40 students whose mathematics anxiety score had reduced the most from pre-test to post-test were sent an e-mail invitation to participate in semi-structured individual interviews. Fifteen students were interviewed. Interview times ranged from 15 to 45 minutes. The interviews were

conducted by the researcher in the researcher's office. Each participant received a stipend of $10.

The researcher developed a set of interview questions to collect information on what the preservice teachers perceived as factors that reduce mathematics anxiety while enrolled in a mathematics content course for elementary education majors. A copy of the interview questions is included in Appendix A.

**Electronic Mail Questionnaires**

Three different e-mail questionnaires were used. The first e-mail questionnaire (E-mail Questionnaire 1) was used as a follow-up to the interviews. Therefore, the 15 students who had participated in the interview phase received and responded to this questionnaire. The questionnaire consisted of three questions – two of which were also asked during the interview. (See Appendix A).

The second e-mail questionnaire (E-mail Questionnaire 2) was sent to the 40 students who showed the greatest increase in mathematics anxiety score. Thirteen students completed the e-mail questionnaire. Each student received a stipend of $5. This questionnaire consisted of five questions – four open-ended questions and one demographic question. (See Appendix A).

The third e-mail questionnaire (E-mail Questionnaire 3) was sent to the 15 participants who had participated in the individual interviews and the 13 students who completed the previously described e-mail questionnaire. This third e-mail questionnaire consisted of one question. (See Appendix A).

## Design of the Study

The design of this research study was qualitative. Krathwohl (2004) stated:

> The qualitative researcher is concerned with how individuals perceive their world and sees reality as an interpretation of these perceptions constructed by each individual (p. 23).

This researcher examined how elementary education majors "perceive their world" and interpreted these perceptions in an attempt to see "reality" in the identification of factors that reduce mathematics anxiety in these students.

## Description of Interview Procedures

Students in the 10 sections of the four mathematics content courses were asked to complete the MARS-SV at the beginning of and upon completion of the spring 2006 semester. The difference in scores from pre-test to post-test was examined. Forty students who showed the greatest reduction in mathematics anxiety based on the MARS-SV results were invited to participate in the interviews. Fifteen students participated in the interview phase of the study.

The researcher conducted semi-structured interviews to determine what factors the preservice elementary teachers perceived as having reduced their mathematics anxiety while enrolled in a required mathematics content course. Research shows that interviews may extract information about individuals' feelings, emotions, and/or thought processes; these emotional and mental processes could be difficult to determine through other methods (Strauss & Corbin, 1998). Additionally, this methodology allowed the researcher to examine and interpret this information based on the perceptions of the preservice elementary teachers.

**Description of Mathematics Content Courses**

All elementary education majors at this university are required initially to take college algebra and then progress through four courses that are in the University elementary education curriculum. Those students enrolled in the pre-kindergarten through third grade certification program typically progress to the survey course, the problem-solving and number sense course, and finally the geometry and measurement course. After the college algebra course, those students enrolled in the first grade through sixth grade certification program take the survey course, the problem-solving and number sense course, the geometry course, and then take an algebraic and proportional reasoning course.

All students completing the MARS-SV were enrolled in one of these four mathematics content courses developed specifically for the University's elementary education curriculum utilizing the *National Council of Teachers of Mathematics (NCTM) Principles and Standards* (2000) as the foundation. Both the NCTM content standards and process standards were addressed during the development of these courses. NCTM content standards include *Number and Operations, Algebra, Geometry, Measurement,* and *Data Analysis and Probability.* NCTM process standards include *Problem Solving, Reasoning and Proof, Communication, Connections,* and *Representation.*

These four mathematics content courses were designed to provide students with a working knowledge of mathematics, the use of concrete teaching materials and models, and the importance of "understanding" before practice. Vital components of the courses include written and oral communication, problem solving, reasoning, and making mathematical connections. Two of the courses – the problem-solving course and the

geometry course – have a critical written component referred to as Problems of the Week (POWs). While referred to as Problems of the Week, students in each course are assigned four to six problems each semester. Students are required to solve the problems and write a step-by step, detailed explanation.

All courses incorporate numerous learning activities involving critical thinking skills and collaborative learning groups. Diverse types of assessments and questions are utilized and are a critical component of the learning/teaching emphasis. All four courses incorporate hands-on activities into many of the lessons. A syllabus for eacb course is included in Appendix B. A description of each course is provided in the following paragraphs.

The first course typically taken in tbe four-course sequence beyond college algebra is a survey course titled *The Nature of Mathematics* and is usually completed during tbe first year of college after completing college algebra. This survey course is taught in two formats: the first format is for students wbo are not science, engineering, or mathematics majors and desire an exposure to mathematics as part of a liberal education, and the second format is specifically for elementary education majors. The sections of this course used for the surveys were of the second format type. The major topics of the course include a survey of probability, statistics, set theory, and logic. The probability portion of the course involves basic rules of probability, counting through combinations and permutations, and expected value. The statistics portion of the course includes topics ranging from representing and describing data with graphs and numbers through topics of sampling techniques, z-scores, and the normal distribution. The set theory and logic portions of the course are limited. Set theory is restricted primarily to basic

understanding of sets through Venn diagrams and counting the numbers in a set. The logic component is restricted to introducing the basics of logic as well as determining the validity of arguments.

The second course taken in the sequence is titled *Number Sense and Open-Ended Problem Solving* and is usually completed during the second year of college. Prerequisite mathematics courses for this course include college algebra and the previously described survey course. The problem-solving course empbasizes open-ended problem solving using manipulatives for concept development and understanding. Broad course topics include problem solving, whole numbers, elementary number theory, integers, fractions, and decimals. The syllabus outlines seven course objectives. Students in this course will bave the opportunity to:

1) develop conceptual understanding of important mathematical principles and bow they are interconnected;

2) increase knowledge of numbers and develop number sense;

3) explore open-ended problem solving;

4) use manipulatives and experience a variety of teaching methods in developing understanding;

5) develop critical thinking skills through problem-solving experiences;

6) express mathematical ideas clearly and correctly;

7) develop an appreciation for the power and beauty of mathematics.

The third course in this sequence is titled *Geometry, Reasoning, and Measurement* and is usually taken during the second year of college. Prerequisite mathematics courses include college algebra, the survey course, and the problem-solving course. Broad course topics include synthetic and coordinate geometry in two and three

dimensions, spatial visualization and counting procedures, symmetries and tilings, and history of geometry. The syllabus lists three goals for the course. It is expected that the students will be able to:

1) develop an appreciation of geometry and how it relates to the real world;
2) develop a deeper understanding of geometric concepts;
3) use the language of mathematics to express mathematical ideas and solutions precisely.

The fourth and final course in the sequence is titled *Proportional and Algebraic Reasoning* and is usually taken the semester prior to student teaching. It is taken in conjunction with an elementary mathematics methods course. Prerequisite courses include college algebra and the previously described courses. This proportional and algebraic reasoning course provides the final link in development of a connected and balanced view of mathematics. Broad topics include interrelationship of patterns, relations, and functions and applications of proportional and algebraic reasoning in mathematical situations and structures using contextual, numeric, symbolic, and graphic representations. This course builds on the foundation of mathematics concepts of problem solving, number and operations, measurement and geometry developed in the two previously described courses. There are seven objectives for the proportional and algebraic reasoning course. It is expected that the students will:

1) increase knowledge, understanding, and application of proportional and algebraic reasoning;
2) develop the mathematical processes of "finding, describing, explaining, and predicting" through the use of patterns;
3) use multiple representations (contextual, tabular, numeric, symbolic and graphic) to understand and make connections among mathematical concepts;

4) understand how math concepts evolve from concrete examples to generalizations expressed by function rules;

5) understand and analyze change in various contexts;

6) develop proportional reasoning skills by comparing quantities, looking at relative ways numbers change, and thinking about proportional relationships in linear functions;

7) develop conceptual understanding of important mathematical principles, their interrelationship, and their vertical development.

The instructional approach in all four courses is nontraditional utilizing hands-on methods as recommended by the National Council of Teachers of Mathematics with an emphasis on teaching for "understanding" as opposed to procedural instruction with an emphasis on skill and drill. The researcher anticipated that students would identify the teaching/instructional approach as a major factor in reduction of mathematics anxiety.

## Data Collection and Analysis

Qualitative methods were used to answer the rescarch question of what factors reduce mathematics anxiety of preservice elementary teachers while they are enrolled in a required mathematics content course.

Forty students whose mathematics anxiety had reduced the most were invited to participate in the interview phase of the study. The researcher conducted face-to-face semi-structured interviews in the researcher's office. The researcher assured the interviewees of confidentiality by informing them that pseudonyms would be nsed for identification and not actual names. In addition, the interviewees were assured that the researcher would be the only person having access to original interviews or interview notes. Appropriate consent (approved by the Institutional Review Board) was obtained

to record the interviews.

The initial portion of the interview involved basic demographic questions to confirm information provided during the semester in which the students were administered the MARS-SV. This portion of the interview was not recorded. The major portion of the interview consisted of the researcher asking questions relating to the preservice teachers perceptions as to what they perceived as having reduced their mathematics anxiety during the duration of the semester. As stated previously, a copy of the interview questions is included in Appendix A.

The researcher transcribed, read, and coded the interview and e-mail questionnaire responses to analyze the data. First, the researcher listened to the audio recordings of the interviews and transcribed all responses. The interview responses were coded by analyzing the answers provided for each question by all participants. All e-mail questionnaire responses were read. The responses were coded by analysis of the answers to each question provided by the participants. The interview and e-mail questionnaire responses were read a minimum of three times for accuracy of coding procedures. Merriam (1998) stated, "[C]oding is nothing more than assigning some sort of shorthand designation to various aspects of your data so that you can easily retrieve pieces of the data" (p. 164). The coding system was of a simple design in that the categories developed as a result of the students' responses. Therefore, categories were created as each interview transcription was read and reread by the researcher. Responses were coded as these categories developed and the coded items were then recorded.

An analysis of interview responses and e-mail questionnaire responses as coded is included in the study's discussion of results. In addition, selected participant responses

are also included in the analysis of responses. "Ultimately, qualitative analysis of data means searching for patterns or themes among the words collected; researchers sort, chunk, and categorize the words, perspectives, and behaviors of the research participants" (McKnight, Magid, Murphy, & McKnight, 2000).

# CHAPTER IV

# RESULTS

The purpose of this study was to identify factors that preservice elementary teachers perceived as having reduced their mathematics anxiety while they were enrolled in a required mathematics content course. The researcher chose qualitative methods including individual interviews and e-mail questionnaires to address the research question. This chapter presents the perceptions of elementary preservice teachers as to what reduced their mathematics anxiety.

Research has indicated that the largest population of university students having mathematics anxiety is that of preservice elementary teachers, also known as elementary education majors (Hembree, 1990; Kelly & Tomhave, 1985). Research also suggests that teachers can transfer mathematics anxiety to their students (Fiore, 1999; Lazarus, 1974; Martinez, 1987; Sovchik, 1996; Wood, 1988).

All data for this study were collected through either individual interviews or e-mail questionnaires. A total of 28 students comprised the sample. The 15 students whose mathematics anxiety level reduced while enrolled in a required mathematics content course were interviewed individually and they subsequently completed e-mail questionnaires. The 13 students whose mathematics anxiety increased during the semester they were enrolled in a required mathematics content course completed e-mail questionnaires, but were not interviewed.

This chapter provides a demographic profile for each participant, including each participant's level of mathematics anxiety decrease or increase, based on MARS-SV scores. In addition, each participant's self-reported mathematics anxiety decrease or increase is included. Lastly and most importantly, participants' responses to three specific interview questions are presented. These questions are directly related to the research question. The interview questions are as follows:

> 1) According *to the MARS-SV survey results, your level of mathematics anxiety reduced during the semester. What specific factors do you believe caused your level of mathematics anxiety to reduce?*
>
> 2) *Comment on the following factors as to how each related to the reduction of mathematics anxiety while enrolled in the mathematics course: Course content? Instructional strategies? Instructor? Writing Component? Manipulative use? Modeling? Usefulness of course as related to major? Evaluation methods?*
>
> 3) *Overall, what factors do you believe would most reduce the mathematics anxiety of elementary education majors while enrolled in a mathematics content course?*

These three questions are subsequently referred to as Question 1, Question 2, and Question 3, respectively.

Fifteen students who showed a reduction in mathematics anxiety answered Questions 1 and 2 during the individual interviews and again in an e-mail questionnaire. The 15 students who showed a reduction in mathematics anxiety and the 13 students who showed an increase in mathematics anxiety answered Question 3, which was asked in an e-mail questionnaire.

Both groups of students were sent a follow-up e-mail questionnaire, which provided a statement concerning mathematics anxiety research and a question related to the statement. The statement and question are as follows:

> *Educational research has suggested that "mathematics anxiety can originate with the attitudes, behavior, and teaching techniques of teachers" and that "teachers can transfer mathematics anxiety" to their students. Do you recall any specific situations during your education that would support this statement? If so, please describe these situations.*

This question will be referred to as Question 4. The responses to this question are presented in this chapter.

Responses to interview questions and e-mail questionnaires were edited when necessary for grammatical purposes. Necessary clarifications of some statements are included in parentheses. Chapter IV concludes with a brief summary.

## Demographic Profiles

Demographic information about each participant is presented in two tables, Tables 1 and 2. Each participant was given a pseudonym; each pseudonym was selected without respect to any characteristics or references to the individual students.

Table 1 provides information about each participant whose mathematics anxiety level reduced based on the MARS-SV results. Table 2 provides information about each participant whose mathematics anxiety level increased based on the MARS-SV results.

**TABLE 1**

**Demographic Information for Students Demonstrating Reduction in Mathematics Anxiety Based on MARS-SV Scores**

| NAME | AGE | •MS % | SR % | cACT | mACT | CA | S | PS | GM | AP |
|---|---|---|---|---|---|---|---|---|---|---|
| **Anita** | 19 | -25 | +117 | 29 | 23 | NA | C* | A | | |
| **Barbara** | 19 | -13 | -33 | 26 | 25 | B | B* | A | | |
| **Carolyn** | 18 | -11 | -50 | 29 | 26 | NA | A* | | | |
| **Debra** | 20 | -26 | -43 | 19 | 21 | C | C | B* | | |
| **Erin** | 20 | -31 | -90 | 26 | 22 | C | | A* | | |
| **Frankie** | 20 | -22 | -50 | 21 | 20 | B | A | B* | | |
| **Gerry** | 28 | -29 | +21 | NA | NA | D | NA | | D* | |
| **Holley** | 20 | -19 | -67 | 23 | 22 | A | B | A | A* | |
| **Ida** | 20 | -16 | -13 | 25 | 22 | A | A | A | C* | |
| **Jan** | 20 | -21 | -29 | 27 | 24 | D | B | A | B* | |
| **Kay** | 19 | -14 | -27 | 23 | 21 | C | B | B | B* | |
| **Lynne** | 39 | -10 | -18 | NA | NA | A | A | C | D* | |
| **Michele** | 20 | -15 | -42 | 23 | 23 | B | A | B | B* | |
| **Nell** | 20 | -25 | -75 | 21 | 21 | C | B | A | B* | |
| **Phoebe** | 21 | -30 | -38 | 28 | 26 | NA | NA | A | A | A* |

•MS (Percentage of mathematics anxiety reduction based on the MARS-SV scores); SR (Percentage of mathematics anxiety reduction or increase as self-reported); cACT (ACT composite score); mACT (ACT mathematics score); CA (College Algebra); S (Survey course); PS (Problem Solving and Number Sense); GM (Geometry); AP (Algebraic and Proportional Reasoning)

*Grade student earned in course when she completed the MARS-SV surveys

**TABLE 2**

**Demographic Information for Students Demonstrating Increase in Mathematics Anxiety Based on MARS-SV Scores**

| Name | Age | •MS % | SR % | cACT | mACT | CA | S | PS | GM | AP |
|---|---|---|---|---|---|---|---|---|---|---|
| **Anne** | 19 | +26 | +650 | 21 | 18 | C | C* | | | |
| **Beverly** | 19 | +35 | +100 | 25 | 24 | A | A* | | | |
| **Courtney** | 19 | +25 | +50 | NA | NA | B | B | B | B* | |
| **Della** | 19 | +40 | -95 | 24 | 18 | B | A | A | A* | |
| **Edie** | 19 | +26 | -90 | 23 | 21 | C | A | A | A* | |
| **Faith** | 20 | +30 | +18 | 27 | 29 | NA | A | A | A* | |
| **Ginny** | 19 | +32 | -54 | 24 | 23 | B | B | B | B* | |
| **Hannah** | 20 | +50 | -98 | 24 | 22 | B | A | A | B* | |
| **Isabella** | 20 | +22 | +70 | 23 | 17 | B | A | | C* | |
| **Jean** | 19 | +22 | -33 | 26 | 27 | A | A | A | A* | |
| **Kim** | 19 | +11 | 0 | 22 | 20 | C | C | B | C* | |
| **Laurie** | 19 | +33 | -33 | 27 | 23 | B | B | B | C* | |
| **Marie** | 27 | +19 | -25 | NA | NA | NA | B | A | B | A* |

•MS (Percentage of mathematics anxiety reduction based on the MARS-SV scores); SR (Percentage of mathematics anxiety reduction or increase as self-reported); cACT (ACT composite score); mACT (ACT mathematics score); CA (College Algebra); S (Survey course); PS (Problem Solving and Number Sense); GM (Geometry); AP (Algebraic and Proportional Reasoning)
* Grade student earned in course when she completed the MARS-SV surveys

There are 11 columns in each table. The first six columns provide the following: pseudonym (NAME), age at time enrolled in course (AGE), percentage of mathematics anxiety reduction based on MARS-SV scores (MS), percentage of mathematics anxiety reduction or increase as self-reported (SR), ACT composite score (cACT), and ACT mathematics score (mACT). The last five columns state the grade earned in each of the required mathematics courses that the participant had completed. Those courses include

the following: college algebra (CA), survey course (S), problem solving and number sense (PS), geometry and measurement (GM), and algebraic and proportional reasoning (AP). An asterisk is inserted next to the letter grade of the specific course that the student was enrolled in during the semester in which she completed the MARS-SV pre- and post-surveys. If a student did not take certain courses for various reasons or could not supply certain information, the entries are indicated by NA (not available).

The 15 students who demonstrated a reduction in mathematics anxiety based on the MARS-SV results participated through individual interviews and e-mail questionnaires. These students ranged in age from 18 years through 39 years with an average age of 21.53 years. The majority of students were 20 years of age. Scores on the MARS-SV ranged from a reduction of 10 to 31 percent with an average reduction of 20.5 percent. At the time of the individual interviews, the students were asked to self-report their change in mathematics anxiety. Thirteen students indicated a reduction in mathematics anxiety ranging from 13 to 90 percent with an average reduction of 44.2 percent. Of the two students who self-reported an increase in the level of their mathematics anxiety, one reported an increase of 117 percent and another reported an increase of 21 percent. Of the 13 students who took the ACT, the composite scores ranged from 19 to 29 with an average score of 24.6. Their ACT mathematics scores ranged from 20 to 26 with an average score of 22.8. It should be noted that the maximum score in each area of the ACT is 36. Four students earned an A in the mathematics course in which they were enrolled during the semester they completed the MARS-SV. Seven earned B's, two earned C's, and two earned D's.

The 13 students who demonstrated an increase in mathematics anxiety based on the MARS-SV results participated through e-mail questionnaires. These students ranged in age from 19 years through 27 years with an average age of 19.8 years. The majority of students were 19 years of age. Scores on the MARS-SV ranged from an increase of 11 to 50 percent with an average increase of 26.7 percent. Through the e-mail questionnaires, the students were asked to self-report their change in mathematics anxiety. Five participants reported increases that ranged from 18 percent to 650 percent. Excluding the outlier of 650 percent, the average increase was 59.5 percent. Seven participants reported decreases ranging from 33 percent to 98 percent with an average of 62.3 percent. One student reported no change. Of 11 students who took the ACT, the composite scores ranged from 21 to 27 with an average score of 24.2. Their ACT mathematics scores ranged from 17 to 29 with an average score of 22. Six of the students earned an A in the mathematics course they were enrolled in during the semester they completed the MARS-SV. Three earned B's and four earned C's.

## Interview and Questionnaire Responses

Fifteen students whose mathematics anxiety reduced participated through individual interviews and e-mail questionnaires. Thirteen students whose mathematics anxiety increased participated through e-mail questionnaires. The interview questions and e-mail questionnaires are included in Appendix A. Responses to the four questions stated previously are provided in the following sections.

**Question 1**

*According to the MARS-SV survey results, your level of mathematics anxiety reduced during the semester. What specific factors do you believe caused your level of mathematics anxiety to reduce?*

This question relates directly to the study's research question and was answered by participants whose mathematics anxiety reduced based on the MARS-SV results. Participants were asked this question in the individual interviews and in an e-mail questionnaire.

Each student's pseudonym is given with a short description of the student followed by her interview **(I)** and e-mail **(E)** response to the question. Since this is the question that was asked to directly answer this study's research question, complete responses were provided to give the reader an opportunity to "listen" to each student. In some cases, other comments made by the student during the interview are included following the interview response.

**Anita** was a 19 year old enrolled in the survey course. She was one of two of the 15 students interviewed who self-reported an increase in her mathematics anxiety level. However, she did respond to the question based on the MARS-SV results, which indicated a decrease in mathematics anxiety.

> **(I)** In the beginning (of the semester), I had a fairly high grade, a high score. I would do the homework at night. Even with me doing the homework, my grade started to falter. I just stopped caring as much. Putting as much time into it would probably cause me to be less anxious. Because I had the attitude that I didn't care. I didn't have an A anymore so shoot for the B. Not what could I do to bring my grade up, it was just to do enough to get that B and keep that B. If it sank lower, then it would have been to do enough

to keep the C. So, the level of anxiety may have gone down because I didn't care as much.

**(E)** In my opinion, the math got harder and my grade started to suffer. I am the kind of person who gives up when things get hard. Therefore, my anxiety went down because my level of caring went way down.

**Barbara** was a 19 year old enrolled in the survey course.

**(I)** I know I didn't struggle that much in that class so I didn't do any outside homework. I just think it was me. I had the mindset that I am going to do well in this class because I have had the teacher before. I kind of know the background of what statistics is and what it is all about. I walked in the class being more confident. Therefore, I think that played out the entire year.

**(E)** The information was more interesting to begin with, so the level of anxiety was much lower throughout the class. I also thought the information was about things that I would use later on in my life so the ability to associate the information with real world instances made things not as difficult. I also liked the way the teacher presented the information. This made all the concepts less difficult to grasp and therefore caused me to be less anxious about the work at hand.

**Carolyn** was an 18 year old enrolled in the survey course.

**(I)** I think being open to the process (decreased my mathematics anxiety). And, then, when you do well it is easy to gain confidence in something. I think if I wouldn't have understood it or would have done poorly then I would have been a little more turned off to it. So, I think that did help me.

**(E)** I believe that a mixture of the professor's teaching methods, the actual simplicity of the subject matter, and my lowered intimidation of the course once I was introduced to the subject matter all helped lower my anxiety level.

**Debra** was a 20 year old enrolled in the problem solving and number sense course.

**(I)** My level of understanding improved. Overall, I guess because I was doing well in the class I enjoyed the semester. Whenever it

came time for the final, I had done well on all of my tests and I was confident the last week of classes when we took the last survey. I was more confident at that point (the end of the semester) than going into the class.

**(E)** My math teacher really took her time to make sure that everyone understood the material. She would go step by step to insure everyone was clear on each step. She also made it clear to let us know what she expected of us in terms of tests and projects so there were no questions of uncertainty. The teacher also did not make the material feel threatening so I was not intimidated by the material. The POWs also helped because it allowed an in depth look at the problem and precise steps to take in problem solving.

**Erin** was a 20 year old enrolled in the problem solving and number sense course.

**(I)** The quality of the teacher and the quality of her really encouraging us to understand what was going on. She was always really willing to help, I think having a teacher that is always willing to help, and knowing that they are there to help encouraged me. That was a really big factor in it.

**(E)** I think that my anxiety was reduced throughout the course mainly because of my instructor. I've always struggled in math and because she was so helpful and I wasn't ever afraid to ask for help, I was able to better understand the material that I was having trouble with. Since I better understood the material, I felt more prepared for my tests.

**Frankie** was a 20 year old enrolled in the problem solving and number sense course.

**(I)** I think because after the first test I went and saw the teacher. Instead of freaking out when I got the test, I guess you could say I just learned to take my time and look at it and just like I knew what to do but I would get so nervous and I would rush. Then I would make small mistakes. So, if I just took my time, just looked at it, slowed down, and just did it, I could do it. I asked her (the teacher) for some tips on how not to be so nervous when I took the test because I was afraid I was going to run out of time and she just kind of told me to take my time and if I knew how to do it, I would finish and everything. She just gave me a few tips.

Student also commented that she practiced the mathematics and kept up with the homework.

> **(E)** I think that the teaching methods helped me a lot.

**Gerry** was a 28 year old enrolled in the geometry course. She was one of two of the 15 interviewed who self-reported an increase in mathematics anxiety. However, she did respond to the question based on the MARS-SV results, which indicated a decrease in mathematics anxiety.

> **(I)** I did go online and read as to how to take tests just to relax. Therefore, those were things that I did and maybe those helped it. At a certain point during the day, well before the test, I stopped studying 2-3 hours before the test. Just absolutely stopped studying. I would eat breakfast and just relax. But, it does not change that even when I got there (to the test), it reminded me when you read the definition – the idea of scatterbrained – like o.k. I can't remember how to do this. And I would have to just stop and try to relax because I couldn't remember what formula works or how this works. And I guess that is what it comes to.
>
> **(E)** If I had to link any factors to the reduction of mathematics anxiety during the semester I was enrolled in the geometry course, I would say it was the instructor's relaxed, hands-on method of teaching. I felt like a child in the classroom discovering new ideas. Also, going to the schools and tutoring may have reduced my anxiety, because I got to transfer the information I was learning to students and assist them in grasping concepts they were having difficulties with.

**Holley** was a 20 year old enrolled in the geometry course.

> **(I)** I would say that the main reason it reduced was that I got used to the class and I understood the way of teaching. I understood how the tests were and I think a lot of it had to do with hands-on examples and activities. Whenever I was taking the test, I could remember those activities and say, 'Oh we did this in class and I know how to do it.' I could relate the material on the test back to the hands-on class activities.

**(E)** I believe that just by simply going to class and trying to understand the material reduced my math anxiety. If I had questions, I would ask them and be sure that I understood them.

**Ida** was a 20 year old enrolled in the geometry course.

**(I)** At the end of the semester, the only thing that was on my mind was I passed. I don't have an A like I had for the previous course, but I actually passed it without understanding all of it so that is good for me. And I was so happy. I even called my mom and told her it was my last math class because she knows I hate it so much. I told her I only have to take one more math and then it is not until my senior year and then I am done with math forever. And the reason I chose this is going to sound awful but the reason I chose my elementary education major is because I looked at the maths and that from other things I had wanted to do like psychology or something like that. And it was the least amount of math. So that is kind of why I chose my major.

**(E)** I think the fact that my math class was ending and I didn't have to take another math class for a long time reduced my anxiety. I also knew that I had passed the class, and that was good enough for me.

**Jan** was a 20 year old enrolled in the geometry course.

**(I)** I really liked the teacher and the teaching style and everything. She (the teacher) gave a lot of examples and she was really open to helping you. Like some teachers you just feel like you can't go up to and ask for help, but I felt comfortable going to her office hours and asking her for help and everything. She worked them (the examples) out step by step making sure you understood each step before going on to the next one.

**(E)** I think that my anxiety reduced due to the relaxed atmosphere of the class. My instructor was extremely helpful and she didn't mind helping any of her students that came to her with any questions.

**Kay** was a 19 year old enrolled in the geometry course.

**(I)** I guess like learning the basics over again and learning to be able to teach those basics. I really don't know why I understood

the information or mayhe it was because it was basic. Just learning it over again.

**(E)** The math that was taught in this geometry course was going back to the basics and seemed simpler to me. I got a chance to relearn some of the hasics of math that I did not remember from when I was younger. I also felt more confident in my abilities in math when I went to tutor the fourth grade. It gave me the chance to help some students and relearn some more information; it also taught me that it is okay if you get some things wrong. No one is perfect.

**Lynne** was a 39 year old enrolled in the geometry course.

**(I)** I took advantage of the help of the professor a lot more than I ever had before. I went to her office hours and received feedback on my performance as far as the labs. That helped. And I also worked with a fellow student (outside of the classroom) who was extremely talented in explaining concepts without prejudice towards me thinking things like this is so easy, you're stupid, and you should know this kind of stuff. At the same class table, I did have someone who would say that 'the answer is what it is because it is just because it is.' The person who explained it to me, took time, and helped me.

**(E)** My knowledge of the material increased; therefore, my level of anxiety decreased.

**Michele** was a 20 year old enrolled in the geometry course.

**(I)** Maybe it did because a majority of our grade was the tutoring and tutoring reports that we did. That to me was something I could do and I knew that I could write about it and go out there and do it. That really helped the grade. In the beginning up until the POW's (Problems of the Week), I was doing pretty good. Not that they made me fail, but I struggled with the POW's and that was introduced in the beginning. Later on going through the material, I saw that the course was not just about the POW's, the material was somewhat easy, and the POW's were not a reason to get so upset about.

**(E)** I think that before the semester started I had heard how difficult this course (geometry) was and how the POW's were much more difficult. Hearing this made me very nervous and

> anxious, after about the first month my anxiety was reduced because I saw that the material we were covering was not difficult. The POW's were very challenging, but because there were a lot more assignments that were weighted more than the POWs, I was relieved that my grade wasn't going to be greatly affected by them.

**Nell** was a 20 year old enrolled in the geometry course.

> **(I)** Help from the teacher and peers, and just being given more information to help me with the stuff that we were given like the problems we were given. More information to work the problems (as time went on). The help from the peers occurred in the classroom after class and during class. Help from the teacher occurred in the classroom and in her office.
>
> **(E)** -teacher always available to help me when I didn't understand
> -peers very helpful to study with me and explain what I was unsure of
> -Tests were more familiar to me after I took the first two; I was not unsure as to what I was going to be tested on and how I would be tested.
> -I learned in the beginning the basics that helped me to build confidence and be able to work through a problem on my own with no doubts.

**Phoebe** was a 21 year old enrolled in the algebraic and proportional reasoning course.

> **(I)** One, I was able fortunately to be successful on the tests that I took and so by the time I got to my last test, there wasn't really any anxiety there. I knew that if I had come to class and taken notes, then I was probably going to be fine. As long as I (had) looked over the notes the night before. I think the way the teacher teaches, how she shows us something and models, and then gives the students a chance to work independently of her, whether it is in groups or actually individually. I think this really prepares you for what you are going to be doing on an assessment. We were given information, not every single type of problem. But the teacher would model a type of problem, not the exact same problem we were going to be doing, but a type and then we would do a similar problem. Then (we would) go do some for homework and then the next class, we would go over them in class. That was another kind of modeling, not before we did it, but after we did the problems. I think and this is really, really broad, but anytime I learn something new and feel like I master it on an assessment, then I feel like my

> broader knowledge has improved and so I feel less anxious about it going in. Overall, I think using the manipulatives and working the problems in a very well explained manner. I keep saying broken down, but that is the thought that keeps coming into my head. This (breaking down the problems) really helped me understand and make connections to things I had learned before and fill in the gaps. I think everything we learned a lot of emphasis was put on building on something else and so you learn things that you learned before and you use them to build on things. It wasn't like just introducing something completely cold.

Student commented that "breaking down a problem" was opposite of a skill and drill course or a course where a rule is given without explaining why and just stating "this is what you have to know."

> **(E)** I believe that the focus on logic and application of the mathematics covered was the reason my level of mathematics anxiety reduced. I was able to understand the material on a deeper level, and therefore felt more comfortable with it.

**Question 2**

*Comment on the following factors as to how each related to the reduction of mathematics anxiety while enrolled in the mathematics course: Course content? Instructional strategies? Instructor? Writing Component? Manipulative use? Modeling? Usefulness of course as related to major? Evaluation methods?*

This question relates directly to the study's research question and was answered by the 15 participants whose mathematics anxiety reduced based on the results of the MARS-SV. Participants were asked this question in the individual interviews and in an e-mail questionnaire. The researcher read the transcribed interview response and the e-mail questionnaire response. Those responses were condensed to form the response reported below **(C)**. Complete statements were retained as often as possible to maintain the integrity of each response. In other situations, responses were carefully paraphrased

to also maintain the integrity of eacb response. If a student did not believe a particular factor contributed to ber reduction in mathematics anxiety, then NA will be recorded for "not applicable." Each student's pseudonym is given followed by her response.

**Anita**

(C) ***Course Content*** – As the content became harder, 1 stopped caring, so my anxiety went down.

***Instructional Strategies*** – Teacher explained things step-by-step.

***Instructor*** – Teacber explained things in detail. There was nothing left to question, and no anxiety.

***Writing Component*** – NA

***Manipulative Use*** – Teacher used many hands on things, which actually belped me learn.

***Modeling*** – Teacber modeled problems and this helped.

***Usefulness of Course*** –I think the education math courses helped me in that I know now I need to explain it in more ways and I need to go slower.

***Evaluation Methods*** – NA

**Barbara**

(C) ***Course Content*** – NA

***Instructional Strategies*** – The visualization that the teacher used was very helpful. She used the overhead and had step-by-step ways of figuring out the problems.

***Instructor*** – I had this teacher before and I loved her. Knowing the teacber and already having establisbed that relationship made the class less of a burden for me.

***Writing Component*** – I think the two projects assigned helped me to see the reasoning behind math problems and gave me the opportunity to physically use the concept in my everyday life.

***Manipulative Use*** – NA

***Modeling*** – Step-by-step method of solving problems for class was helpful.

***Usefulness of Course*** – I will definitely take what I learned and be able to put my own personal knowledge to good use when I am teaching my students about this topic.

***Evaluation Methods*** – Since I had already had the teacher, I was familiar with her style of examinations. This belps to SIGNIFICANTLY decrease anxiety.

**Carolyn**

(C) ***Course Content*** – The course content contributed to my reduction a lot. Making connections to real life and other things we had already learned gives it meaning.

***Instructional Strategies*** – The teacher used many concrete examples and incorporated hands-on assignments and illustrations to help us understand. She would tie it to a real-life example.

***Instructor*** – She was more than willing to explain or provide help outside of class. The instructor was highly related to my reduction in math anxiety.

***Writing Component*** – The writing component was a way for me to take something that I excelled in and apply it to mathematics.

***Manipulative Use*** – Things like that helped. I am kind of just a paper and pen kind of girl.

***Modeling*** – The best for me were worked examples that she did. Anything that could explain the concept that was written down worked for me.

***Usefulness of Course*** – It was very useful as an education major.

***Evaluation Methods*** – Her quizzes were very helpful in lowering my anxiety, because if I studied those then I knew what to expect for the test.

**Debra**

(C) ***Course Content*** – I did not find the material extremely difficult and the teacher made the content fun.

***Instructional Strategies*** – My teacher took baby steps, which helped me to fully understand the concepts.

***Instructor*** – The teacher was extremely nice and helpful. She didn't get frustrated if we asked questions.

***Writing Component*** – I think it helped because you had to know each step to take.

***Manipulative Use*** – It definitely helped because you got a hands-on approach in understanding the material.

***Modeling*** – She always started by showing how to do everything on the overhead and then walked around to make sure we understood.

***Usefulness of Course*** – I found it helpful, because it evaluates how as a teacher you would explain the material and the manipulatives were helpful.

***Evaluation Methods*** – I think they helped because there were several different evaluation methods including quizzes, tests, journals, and POWs.

**Erin**

(C) ***Course Content*** – I had the mindset that I was going to be learning how to explain things to the students, so I dedicated my time to learning that and my anxiety reduced. The important thing was that we actually understood what we were learning.

***Instructional Strategies*** – Group work was great to be able to feed off the people working with me and to be able to solve things in a group and to discuss. Having the teacher up in the front of the class writing things down so that I could visually see it and work hands-on with manipulatives was very helpful.

***Instructor*** – The instructor actually cared about what we were learning and how well we were learning and implementing these things into our assignments. It wasn't simply about teaching a subject to get the right answers.

***Writing Component*** –Just being able to explain things of how or what I was learning in the class is what I think was the most useful thing in the class that I would be using in my career.

***Manipulative Use*** – I enjoyed using the manipulatives very much because it was great to be able to actually see the things we were learning in "real life" examples.

***Modeling*** – Modeling gave me something to go by when I was working on certain problems or methods.

***Usefulness of Course*** – The course was extremely useful. I learned to break down the simplest of concepts and explain them on an elementary level, and I loved it.

***Evaluation Methods*** – I liked the way we were evaluated and that there were many parts of the evaluation process of the course. I made an A in the course and I think it was because I did not have to focus on simply one way to make my grades in the course.

**Frankie**

(C) ***Course Content*** – The course content helped because it showed why something was the way that it was. Seeing how things work helps me understand.

***Instructional Strategies*** – The manipulatives played a big part in the instruction and the teacher not moving on until everyone understood the information helped me.

***Instructor*** – The teacher was patient and she wanted everyone to succeed. This helped.

***Writing Component*** – This helped me because it required me to explain a topic so it helped me learn.

***Manipulative Use*** – They helped me because it showed me why thing worked and why they didn't.

***Modeling*** – Again, this helped because you could visually see what was going on and what the teacher was trying to show you.

***Usefulness of Course*** – The class gives you many different strategies on how to teach math, which emphasizes understanding.

***Evaluation Methods*** – NA

**Gerry**

**(C)** ***Course Content*** – NA

***Instructional Strategies*** – The use of interactive instruction was a fundamental part of the class.

***Instructor*** – The teacher was relaxed and patient in presenting the material.

***Writing Component*** – This was one of the most beneficial parts of the course for me; it allowed me to put into words how a method worked. It just helped me understand a little bit better again the whole idea.

***Manipulative Use*** – This was helpful because I am a very hands-on person, so this allowed me to physically recreate objects that are abstract when on paper. This allowed me to comprehend why a concept worked.

***Modeling*** – Modeling was a key component in helping me grasp the various concepts.

***Usefulness of Course*** – I think the usefulness of the course could have reduced my anxiety, especially when we went to the schools and we tutored students on the same topics we had just learned in the course.

***Evaluation Methods*** – We had tests, journals, quizzes, tutoring reports, and POWs. So, I would say that helped because it is constantly on your mind. You are constantly preparing for the tests without even knowing it.

**Holley**

**(C)** ***Course Content*** – I felt that the course content was easy to understand and made sense to me and the way that many things were hands-on helped me to understand and remember it.

***Instructional Strategies*** – I think the hands-on activities really had a lot to do with it (reducing my anxiety). It gave you visualization.

***Instructor*** – The instructor for the course helped to reduce my anxiety because she was very approachable and I wasn't afraid to ask questions.

***Writing Component*** – The whole point of these math classes was to be able to explain math. So, by having to list out every single step, I understood it better and I had to force myself to understand why I did what I did.

***Manipulative Use*** – I thought that the use of manipulatives was very helpful. When it came test time, I could just think back to them and remember what I learned.

***Modeling*** – Modeling helped. The teacher asked questions when she modeled problems. The interaction helped and allowed us to think about the situation.

***Usefulness of Course*** – This did help. You had to buy the supplies (manipulatives) with the book. As I tutored students, I could see myself understanding the concepts. That definitely reduced the anxiety because I trusted myself more.

***Evaluation Methods*** – It (the different evaluations) made me think of the same things in different ways. Whenever I would solve a problem, I could think back to all the different ways that I had gone about it before.

**Ida**

**(C)** ***Course Content*** – I was more successful in geometry in high school than algebra, so this could have reduced my anxiety a little.

***Instructional Strategies*** – I liked the hands-on activities because I understood them more. The computer quizzes forced me to work problems over and over.

***Instructor*** – NA

***Writing Component*** – It relates to reducing my anxiety because I am great in writing.

***Manipulative Use*** – I loved this. It reduced it (anxiety) because most of the time with manipulatives, I actually understood it when we were done.

***Modeling*** – NA

***Usefulness of Course*** – NA

***Evaluation Methods*** – Overall, it (the different assessments) did reduce my anxiety because if I only had tests I would have been completely stressed out.

**Jan**

**(C)** ***Course Content*** – The initial idea of geometry made me anxious, but it was more application than memorization. I was a lot more comfortable in the class.

***Instructional Strategies*** – She used many examples and made sure you understood. She used a variety of assessments.

***Instructor*** – she was helpful with everything, she taught the material clearly, and I was able to follow along and learn the material. She was also personable.

***Writing Component*** – Writing things down was a big help. It helped me to see step by step what I had done.

***Manipulative Use*** – Manipulatives were a big help because you could put your hands on something concrete.

***Modeling*** – It helped because you were able to see the problems being explained.

***Usefulness of Course*** – It helped because I was able to relate the entire course to my major and to what I would be doing in the future.

***Evaluation Methods*** – Evaluation was varied, so no one thing or test was valued so much.

**Kay**

(C) ***Course Content*** – The math was simpler and it gave me a chance to relearn the basics.

***Instructional Strategies*** – The teacher gave out packets of worksheets that helped me practice.

***Instructor*** – I did not see the teacher outside of class because I have never been comfortable talking to teachers. However, she went over things over again in class if you did not understand the first time.

***Writing Component*** – Writing the notes and filling out the information in class so I could go over it later helped me a lot.

***Manipulative Use*** – The manipulatives used in class helped me understand what we were doing in class.

***Modeling*** – The modeling that the teacher did on the overhead was useful. She did help me to write the specific steps down and that helped me because I could look back.

***Usefulness of Course*** – It helped me because I can now remember the basics in math that I have forgotten.

***Evaluation Methods*** – There were different types of evaluation that helped.

**Lynne**

(C) ***Course Content*** – It built upon the very first concept to the last one. The material was sequential which helped.

***Instructional Strategies*** – The manipulative use decreased my anxiety. The teacher went over problems from beginning to end.

***Instructor*** – The instructor's willingness to help during office hours did semi-reduce anxiety.

***Writing Component*** – I have no problem with the writing component so that was always a bonus for me. The writing component helped to reduce my math anxiety.

***Manipulative Use*** – The use of manipulatives increased my confidence and gave me a visual of what we were asked to learn.

***Modeling*** – This tactic decreased my anxiety because it was something I could refer to wben studying.

***Usefulness of Course*** – NA

***Evaluation Methods*** – The POWs and the tutoring reports helped in reducing my math anxiety because I am comfortable writing. Tests did make me anxious.

**Michele**

**(C)** ***Course Content*** – Because the course content was not as difficult as I had thought, my anxiety level went down.

***Instructional Strategies*** – All of the methods my teacber used eased my fears of not being able to keep up or succeed. I liked all the bands-on activities.

***Instructor*** – I enjoyed my gcometry teacber and thought that her explanations and constant help in the classroom definitely belped reduce my anxiety towards math.

***Writing Component*** – I think that the tutoring reports definitely made it a lot better because it was something I could do and I knew it would belp my grade.

***Manipulative Use*** – They gave good hands-on experience and allowed me to visually see concepts rather than just reading them in books. I really liked that.

***Modeling*** – That belped because it was better than just writing it down. You could see it three-dimensional.

***Usefulness of Course*** – Going out into the scbools gave you first hand view of working with math students.

***Evaluation Methods*** – Evaluation methods belped ease my math anxiety because we were given many different types of assessments.

**Nell**

**(C)** ***Course Content*** –The course content gave me the basics to grow on.

***Instructional Strategies*** – I liked being able to work the problems and have hands-on assignments.

***Instructor*** – My instructor was always there for me and was never judgmental. This helped me to lower my level of anxiety because I was comfortable with the teacher.

***Writing Component*** – Writing out solutions to problems was helpful.

***Manipulative Use*** – The manipulatives were very useful in class to help me understand certain ways problems worked.

***Modeling*** – I could watch my teacher or peers work/model a problem and have confidence that I could also work the problem successfully.

***Usefulness of Course*** – Anxiety was reduced because I was successful in the class and able to learn the concepts and how to teach the concepts that I will one day be teaching.

***Evaluation Methods*** – The writing assignments did not help to reduce my anxiety. The tests and quizzes helped me very much because I knew what was expected of me after the first test or two.

**Phoebe**

**(C)** ***Course Content*** – I think it did relate to reducing my anxiety because it related back to some topics that I had trouble mastering the first time around.

***Instructional Strategies*** – The instructor modeled each type of problem for our class, so I always felt comfortable when it was time for me to complete a problem. Peer tutoring helped.

***Instructor*** – The way the teacher taught by modeling and introducing the concepts helped reduce the math anxiety for me. She also had a very nurturing personality.

***Writing Component*** – The opportunity to write during the semester especially on tests and to explain things helped to reduce my math anxiety.

***Manipulative Use*** –I think manipulatives are key in reducing math anxiety by showing how a math problem can physically be solved without some kind of abstract algorithm that I didn't understand.

***Modeling*** – The instructor modeled each type of problem for our class, so I always felt comfortable when it was time for me to complete a problem.

***Usefulness of Course*** – NA

***Evaluation Methods*** – We were given quizzes in addition to major tests. This helped reduce my anxiety by allowing me to check my understanding of concepts before major assessments were given.

**Question 3**

*Overall, what factors do you believe would most reduce the mathematics anxiety of elementary education majors while enrolled in a mathematics content course?*

All 28 students – the 15 who demonstrated a decrease in mathematics anxiety based on the MARS-SV results and the 13 who demonstrated an increase in mathematics anxiety based on the MARS-SV results – answered two identical questions in an e-mail questionnaire. The above is the first of those two questions.

Each student's pseudonym is given along with the e-mail response **(E)**. The first 15 responses are from the students who participated in the individual interviews and whose MARS-SV results indicated a reduction in mathematics anxiety.

| | |
|---|---|
| **Anita** | **(E)** Overall, I think that making a set schedule, STAYING with that schedule, and making things not hard to comprehend. Also, take the extra time to explain things are questionable, and only teach things that matter. |
| **Barbara** | **(E)** I would say that at any point in time that the information being presented can be tied into real world instances and used in our own classroom in the future needs to be mentioned. If the teacher mentions the way I can use the information in the future, it makes it more meaningful! |
| **Carolyn** | **(E)** I believe that the professor's approach to the class and the course material is central to decreasing anxiety, and I feel that using concrete examples and fair evaluation methods are next in line in importance of reducing anxiety. |
| **Debra** | **(E)** I think that working more with elementary students would help and not going too fast through the material. The POWs help as well as the journals so the teacher knows how the students feel. |
| **Erin** | **(E)** I think it is the quality of the instruction given. The teacher plays a large role in reducing mathematics anxiety – especially with elementary education majors. Generally, a nurturing teacher would be better received, simply |

| | |
|---|---|
| | because the majority of the class would relate well to that. Also, POWs are extremely important, being taken back to the explanation of simple concepts is a necessary process of not only understanding how to do something, but why we teach it in the first place – and why it is important to teach. |
| **Frankie** | **(E)** The teaching methods of the instructor and the content of the course. |
| **Gerry** | **(E)** I would say that the factors that most related to a reduction in my mathematics anxiety was the teacher's relaxed method of teaching and the being able to go to schools and tutor students using the concepts that I learned in class. |
| **Holley** | **(E)** The only thing that I think would be helpful would be to have students discuss their tutoring experiences with each other in a class discussion and be able to ask one another questions and learn from each other. |
| **Ida** | **(E)** POW's and using manipulatives for as much as you can. Also, if the teacher realized that math is not everyone's strong subject. |
| **Jan** | **(E)** Being able to go out in a school and teach what you had just learned about in class helps in being able to retain that knowledge. Also, having a mix of assignments to do helps with anxiety. |
| **Kay** | **(E)** More worksheets with problems and examples, along with the answers and filled in notes so that the students could listen to the lessons and examples rather than furiously writing notes so that they have all the information and listen to the lectures at the same time. |
| **Lynne** | **(E)** I believe gaining greater confidence in my own ability to perform efficiently in a mathematics course would greatly reduce my anxiety. The role of the instructor is one that would allow student anxiety to be reduced; the manner in which the subject is approached and presented plays a role in my reduction of anxiety. |
| **Michele** | **(E)** The continued use of manipulatives and many hands-on experiences in learning the course material is beneficial. I think after getting through the first few weeks and seeing that the material is not that hard the anxiety will lower. |

**Nell** (E) I think that anxiety would be reduced by supplying the students with examples of how test questions will be worded on the test. Another way would be to set up a study group where the students can meet either during class time or outside of class to help each other with the comprehension of materials and problems. Also provide a student with helpful hints on how to take a test in whichever math course he/she is enrolled.

**Phoebe** (E) Modeling work for students and letting students know specifically which concepts will be covered on a test.

The following are responses to the same question (*Overall, what factors do you believe would most reduce the mathematics anxiety of elementary education majors while enrolled in a mathematics content course?*) from the 13 students who demonstrated an increase in mathematics anxiety based on the MARS-SV results.

**Anne** (E) I think to reduce anxiety would be to give a detailed review, and then to make the test comparable to the review given.

**Beverly** (E) Limit the amount of homework. Sometimes it gets to be a lot of extra practice, which is good but can be tedious.

**Courtney** (E) I think if the students were made aware of what they were getting into before taking the class I feel it would lessen their anxiety and maybe actually let them have a hands on part in teaching something that had to do with the material.

**Della** (E) I do not believe anything should be changed to reduce anxiety in math courses. In my own situation, a little anxiety helped me to focus more and perform better.

**Edie** (E) It's hard to say, but maybe hearing from past students would put them at ease. Beginning the course with easy concepts to allow students to get a feel for the professor's teaching strategies always helps to make me feel a bit more at ease.

| | |
|---|---|
| **Faith** | **(E)** Maybe if, in the beginning of the semester, the teachers of the class could explain how important it is to know the information that will be used continuously throughout the class and tell the students to strive to learn this information in order to do well on other lessons. Quizzes could be given on the important topics and information, both at the beginning of the year and continuously throughout the year in order to let the students know it will always need to be remembered and known. I think there should be less of a focus on exactly how to teach students with more emphasis on the mathematical concepts. |
| **Ginny** | **(E)** I think anxiety could be reduced by maybe allowing extra credit, or once the student gets the test back – being allowed to fix the mistakes for partial credit added to the grade. |
| **Hannah** | **(E)** I felt that the tutoring experience was very enlightening and it gave me a chance to apply what I've learned in the past education math classes to real children who needed the help. I would say that something needs to give in the area of how many POWs and/or online quizzes and assignments due. |
| **Isabella** | **(E)** I firmly believe that the "daily grade" quizzes helped reduce mathematics anxiety that many members of the class faced. Although the quizzes did not eliminate the mathematics anxiety that I personally faced, I do believe that it reduced the intensity of my anxiety. |
| **Jean** | **(E)** I would have felt much less anxious about entering geometry if I had talked with a student who took the course the past semester and was able to know what I would be learning about that semester. |
| **Kim** | **(E)** Well for me, it is easier when the teacher explains topics in a basic way, going through it step by step and not assuming that we know something we may have learned in the previous course. It's also good to go over previous concepts and problems periodically to assure we understand the material. |
| **Laurie** | **(E)** I believe that math skills should be taught with effective methods early on to help reduce math anxiety in elementary education majors. The course should also be clearly laid out at the beginning of the semester, with |

precise test dates, and what content is included on those tests so that there is no confusion or uncertainty.

**Marie** **(E)** I believe that a great deal of the anxiety has to do with the fear of the unknown. As a student who plans to teach math it made me nervous thinking about teaching children something that I was unsure of myself.

**Question 4**

*Educational research has suggested that "mathematics anxiety can originate with the attitudes, behavior, and teaching techniques of teachers" and that "teachers can transfer mathematics anxiety" to their students. Do you recall any specific situations during your education that would support this statement? If so, please describe these situations.*

All 28 students – the 15 who demonstrated a decrease in mathematics anxiety based on the MARS-SV results and the 13 who demonstrated an increase in mathematics anxiety based on the MARS-SV results – were asked this final question in a follow-up e-mail questionnaire.

Each student's pseudonym is given along with the e-mail response **(E)**. The first 15 responses are from the students who participated in the individual interviews and whose MARS-SV results indicated a reduction in mathematics anxiety.

**Anita** **(E)** I don't recall any teacher ever having anxiety towards teaching me math. To me, they all seemed confident, at all times. The closest thing to that I've ever come is a teacher in high school who would at times, get the answers to the problems she was explaining wrong. It was always a simple error though, and caused me no anxiety.

**Barbara** **(E)** I would absolutely agree with those statements. I can recall an instance in math where the teacher openly said that if you don't study for her tests, you will definitely fail. That can cause any student to feel added pressure. As if the

material isn't hard enough, just that simple statement can cause undue stress in the classroom. It is highly unlikely that any 'good' student would not study for a test but with statements and comments like the above, it just makes the anxiety of test taking even that much harder on a student. The incident I am referring to bappened a few times because many teachers use that scare tactic in order to make students feel like maybe they can't handle the course load or they are going to fail if they do not focus on their schoolwork.

**Carolyn** **(E)** Did not respond

**Debra** **(E)** Some of my teachers were not very encouraging. Some would become very upset if you could not catcb on fast enough. I also remember some of my teachers making mistakes wben writing on the board. That used to confuse me a lot.

**Erin** **(E)** When I was in elementary school, math was actually my favorite subject. My teachers seemed to love it, and hence, so did I. I looked forward to and excelled in mathematics. When I got to middle school, I still enjoyed math until my 8th grade pre-algcbra year. My teacher, I distinctly remember, did not enjoy nor did she understand algebra very well. I did poorly on tests, and upon receiving them, I did not get feedback on how to improve; and from then on, I baven't enjoyed math. My first year of high scbool, I did extremely well in algebra, but I still did not enjoy it. As the math got more and more complex, I got more and more anxious. So, I can speculate that bad my pre-algebra teacber been more competent of the subject - or at least pretended to be excited about it - I would not have had to go through all the mathematics anxiety that I went through from late middle scbool to the end of my sophomore year after taking the problem solving and number sense course.

**Frankie** **(E)** I remember wben I was in the tenth grade and I was taking Algebra I the teacher that I had was not very nice and sbe would get angry when the class did not understand something after sbe explained it. The teacher really did not explain the lessons very well to the class so wben she would give us problems to do, others and I did not really know bow to do them and she would get mad at the class. By her not explaining well and then expecting us to know

how to do the problems she added to my already high anxiety about math.

**Gerry** **(E)** I cannot recall any math teachers that may have contributed to my math anxiety. One situation has continually come to mind every time you have mentioned the subject of math anxiety. One time I remember, I was having difficulty learning how to count money and tell time. I remember my mother tried to help me in these areas. However, I was not able to catch on to the concept. It seems that my mother always got frustrated with trying to teach me different concepts when I brought math homework home.

**Holley** **(E)** I haven't ever experienced math anxiety passing from a teacher to myself. I can, however, see how it would affect a student's learning experience of math. I feel that if a teacher has visible math anxiety, their students would be able to sense that and feel it as well.

**Ida** **(E)** I believe that the attitude of my teachers and their techniques did give me anxiety. Not every teacher in my past gave learning options and I'm more of a hands-on person. I also vaguely remember my teachers when I was a little older getting frustrated with some questions I had. I think I just think too much about problems and make them harder than what they really are. I also remember some teachers starting the lesson by saying that this concept was going to be difficult. It always freaked me out when they did that!

**Jan** **(E)** I agree with this statement. I had a teacher in high school who really didn't know what he was teaching and his frustrations with the material translated to almost every one of his students he had.

**Kay** **(E)** I do remember in middle school (6th grade) being put into "low math" because my grades were not good enough to be in middle or high math. That was the first time I can remember not liking math. It was very hard and even though low math probably did help me a little because there were only five other people in my class it still labeled me and I felt like I was stupid. I did try harder and moved to middle math in the 7th grade but I still felt like whatever I did was not good enough. From middle school on, I have

disliked math and felt as if I could not do it or figure it out right away and I was not good enough.

**Lynne** **(E)** I believe the answer would have to be yes. When I was in 8th grade, the teacher would go around the room and strike the students on the back of the hand with a ruler if they gave the incorrect answer. In that instance, his attitude/behavior towards incorrect answers was intimidating. I believe I probably felt anxious at that time.

**Michele** **(E)** I think that this is very true. I can remember in 7th and eighth grade I had the same teacher and almost everyone hated the class. The teacher was always very strict and taught straight from the book and with very repetitive assignments. I do not remember ever having hands-on experience and I found that because she was so repetitive in teaching every lesson. She did not do much to further our understanding. It rubbed off on the students because we knew if we did not understand something the first time chances were that you probably would not ever understand it and you would do badly on the test. If you did not do well on her types of tests and assignments, then you had little hope of making a good grade in the class.

**Nell** **(E)** I think that teachers do in a sense cause anxiety on the students. I can recall teachers from all levels of my education starting a lesson saying that the following concept was going to be hard to catch on to. Teachers also in my prior experiences have made comments about how previous classes did not do too well on this test or assignment. This would always cause anxiety in me because I was preparing myself to do poorly like the previous students rather than just learning the new concept and doing the best I could.

**Phoebe** **(E)** While I believe that this statement could be true, I have never experienced anything personally that would support it.

The following are responses to the same question (*Educational research has suggested that "mathematics anxiety can originate with the attitudes, behavior, and teaching techniques of teachers" and that "teachers can transfer mathematics anxiety" to*

*their students. Do you recall any specific situations during your education that would support this statement? If so, please describe these situations.*) from the 13 students who demonstrated an increase in mathematics anxiety based on the MARS-SV results.

| | |
|---|---|
| **Anne** | **(E)** I think that when it comes to this quote it is very true for me. I have a lot of math anxiety simply based on the teacher. I found when I was younger if I was "called out" in class, I got very nervous. I know not all students are like this, but for me being called out gives me a great deal of math anxiety. |
| **Beverly** | **(E)** I cannot really recall a specific situation, but I do remember when we would have standardized tests and the teachers would be stressed out about us passing them. They would tend to pass that stress on to their students. |
| **Courtney** | **(E)** I don't think I had any instances where a teacher of mine gave me mathematic anxiety. |
| **Della** | **(E)** I can recall the anxiety I felt in 4th grade over simple math facts. I believe these feelings did originate from my teacher. Weekly, the teacher would administer timed math quizzes. We had 1 minute to answer as many multiplication (sometimes division) problems as we could. These tests made me extremely anxious about math, as I could not work problems that quickly under pressure. I also used to get anxious about math performance when any teacher would stand over my shoulder during a test. |
| **Edie** | **(E)** I cannot ever recall an obvious attitude towards math coming from the teacher due to her past experiences. |
| **Faith** | **(E)** I don't specifically recall any situations throughout my educational experience that would support this statement. |
| **Ginny** | **(E)** I do think I have had anxiety that I felt with math due to teachers' attitudes and outlooks. I have had teachers that assume the student knew what she was doing, and didn't spend time working through a subject. I have also had teachers that seemed unamused with math, therefore making me uninterested. |
| **Hannah** | **(E)** The summer between 7th and 8th grade, my parents enrolled me in a 3-week algebra course led by the newly |

| | |
|---|---|
| | elected superintendent of the school board in my district. He had a demanding personality and thought very highly of himself. He sped through the material quickly, assuming that the 12 and 13 year olds knew that letters represented an "unknown" factor. Every day I had homework and I had no idea how to even attempt it. My dad was the "math person" and my mom claimed she didn't remember much so he attempted to help me with my homework. Every night he would lose his patience, I would end up in tears, and we would yell at each other until my mom cut in and said I didn't have to finish it. I suppose half way through the program my parents finally concluded that they had wasted my time and their money by sending me to this program. The consequence of my experience was my fear of algebra. |
| **Isabella** | **(E)** I do not believe that my anxiety toward mathematics "originated" or resulted from the attitudes, behavior, and teaching techniques of any particular teacher that I had throughout my educational career. |
| **Jean** | **(E)** While I never first handedly experienced a situation where a teacher might pass along mathematics anxicty, I did have a friend whose teacher told him that since he was a boy, he should have no problem excelling in math. For the next few years, he was always very anxious about math because he felt that his teacher was saying that real men can do math. Thankfully, I never had a teacher who told me similar things. |
| **Kim** | **(E)** I can recall that teachers who went fairly fast in explaining issues/concepts made me feel more nervous because it didn't leave much time to think and process what is being taught. Also, some teachers weren't very patient with us if we didn't understand a concept and it made me feel anxious. |
| **Laurie** | **(E)** No, I do not recall any specific situations during my education that would support that statement. |
| **Marie** | **(E)** In high school I had a hard time with math. I would struggle in class just to keep up and memorize just enough information to make a good grade. When doing homework my father would get very frustrated with me. He is an engineer and he did not understand why math was so hard for me. I believe this is what caused my anxiety in the subject of math. |

## Summary

Responses were based on audiotaped individual interviews and e-mail questionnaires. With the exception of demographic questions, all questions during the interviews and in the e-mail questionnaires were open-ended. All responses to questions directly relating to the research question were reported to provide a complete and thorough account of each student's perceptions.

Each student provided her own perceptions relating to each question, but there were common threads throughout the responses. These common threads are the focus of this research study and are discussed in Chapter V.

# CHAPTER V

# DISCUSSION

One purpose of this research study was to contribute to the mathematics anxiety research related to elementary preservice teachers, also known as elementary education majors. The researcher examined the perceptions of elementary education majors enrolled in mathematics content courses in a specific attempt to determine what factors reduce the mathematics anxiety levels of these students.

The rationale presented for this study cited research indicating that the largest population of university students having mathematics anxiety is that of preservice elementary teachers (Hembree, 1990; Kelly & Tomhave, 1985). Research suggesting that teachers can transfer mathematics anxiety to their students, was also cited (Fiore, 1999; Lazarus, 1974; Sovchik, 1996; Wood, 1988).

Twenty-eight students participated in this research study – 15 students whose mathematics anxiety decreased while enrolled in a required mathematics content course and 13 students whose mathematics anxiety increased while enrolled in a required mathematics content course. In an effort to confirm the existing research and to justify this research study, all 28 students were asked the following question in an e-mail questionnaire:

> *Educational research has suggested that "mathematics anxiety can originate with the attitudes, behavior, and teaching techniques of teachers" and that "teachers can transfer mathematics anxiety" to their students. Do you recall any specific situations during your*

*education that would support this statement? If so, please describe these situations.*

Of the 15 students demonstrating a decrease in mathematics anxiety, 14 responded. Ten of these 14 (71 percent) stated that they recalled specific situations that supported the above research statement. All 13 of the students who demonstrated an increase in mathematics anxiety responded. Seven of these 13 (54 percent) stated that they also recalled situations supporting the statement.

Of the 27 respondents, a total of 17 (63 percent) responded that they recalled specific situations supporting the research statement. Eleven of the 17 (65 percent) indicated at what stage of their education the specific situation occurred. One student indicated that the incident occurred in elementary school, with five students indicating middle school, three students indicating high school, and one student indicating college. One student stated that such situations had occurred throughout her education. Each of the 17 students related stories of how her mathematics anxiety originated with teachers. Four of these stories are provided, as follows:

First, Della was a 19 year old whose mathematics anxiety increased during the semester. She was enrolled in the geometry course. Della stated that one specific incident occurred in fourth grade when her teacher required the students to complete timed multiplication tests. Della also said that this teacher would frequently stand over her (Della's) shoulder as she worked problems. Della believed both incidents were sources of her mathematics anxiety.

Lynne was a 39 year old whose mathematics anxiety decreased while enrolled in the geometry course. She reported that her 8$^{th}$ grade mathematics teacher was very intimidating and was a source of her mathematics anxiety. Lynne said that the teacher

would walk around the room and strike students on the hand with a ruler if they answered a question incorrectly.

Jan was a 20 year old, enrolled in the geometry course, whose mathematics anxiety decreased during the semester. She stated that she had a high school mathematics teacher who appeared to not know the subject matter and would get very frustrated with the students. Jan stated that the teacher's frustration "translated to almost every one of his students."

Lastly, Barbara was a 19 year old who had a decrease in mathematics anxiety while enrolled in the survey course. She told the story of college teachers who used "scare tactics" in mathematics classes. Barbara said she recalled an instance in math where the instructor openly said that if a student did not study for tests, then that student would definitely fail. Barbara did say that while it is unlikely that good students would not study for tests, statements like this add pressure and anxiety.

Sixty-three percent of the respondents did recall and describe situations during their education in which their mathematics anxiety stemmed from some type of teacher behavior. These results do reinforce existing research, which suggest that mathematics anxiety originates with teachers and that teachers transfer mathematics anxiety to their students.

To produce teachers with lower mathematics anxiety, it is imperative to identify and to understand the factors that reduce the mathematics anxiety of preservice elementary teachers. Once these factors are identified, then mathematics instructors of preservice elementary teachers can be informed. In a conscious effort to reduce mathematics anxiety of preservice elementary teachers, university instructors can

implement classroom strategies and/or teaching techniques employing these factors. Then, if these future elementary teachers have lower levels of mathematics anxiety, it follows that their students will have lower levels of mathematics anxiety.

Because it is imperative to identify the factors that reduce preservice teachers' mathematics anxiety, one research question was the guiding force of this study. That research question is as follows:

> What factors do preservice elementary teachers perceive as having reduced their mathematics anxiety while they were enrolled in a required mathematics content course?

Twenty-eight female preservice elementary teachers participated in this study. All students were enrolled in a large public higher education institution located in the south central portion of the United States. Data collection methods included individual interviews and e-mail questionnaires. Responses to questions directly connected to the research question were transcribed; these responses were presented in Chapter IV. All responses were analyzed and the analysis of these responses is presented in Chapter V. The focus of this chapter is the interpretation and discussion of responses as they relate to the research question. Chapter V also includes conclusions, implications, and recommendations from this research study's results.

## Interpretation of Results

The intent of the research question was to identify factors that reduce mathematics anxiety of preservice teachers enrolled in a required mathematics course. Fifteen participants, whose mathematics anxiety reduced, were asked to identify these factors in

individual interviews and in an e-mail questionnaire. Two specific questions were asked in an attempt to identify these factors. The questions are as follows:

**Question 1:** *According to the MARS-SV survey results, your level of mathematics anxiety reduced during the semester. What specific factors do you believe caused your level of mathematics anxiety to reduce?*

**Question 2:** *Comment on the following factors as to how each related to the reduction of mathematics anxiety while enrolled in the mathematics course: Course content? Instructional strategies? Instructor? Writing component? Manipulative use? Modeling? Usefulness of course as related to major? Evaluation methods?*

All responses were coded and analyzed. The researcher summarized and condensed the responses to Question 1. These responses are presented in Table 3. In order to represent the responses to Question 2, all factors, which each participant believed caused their mathematics anxiety to reduce, are indicated in Table 4.

**TABLE 3**

**Responses to Question 1**
**Factors Identified by Participants That Reduce Mathematics Anxiety**

| Name | Factors |
|---|---|
| **Anita** | Gave up because math got harder |
| **Barbara** | More confident; Interesting information applicable to real life; Like the way teacher presented information making concepts easier to grasp |
| **Carolyn** | Doing well increased confidence; Understanding material; Teacher's teacbing methods; Lowered intimidation after introduction to course; Simplicity of material |
| **Debra** | Doing well in the course; Increased confidence; Teacher's step-by-step teaching technique for better understanding; POWs |
| **Erin** | Quality of teacher; Encouragement of teacher; Teacher's willingness to help; Better understanding of material |
| **Frankie** | Teacher's tips for taking tests; Teaching methods |
| **Gerry** | Online test-taking tips; Teacher's hands-on teaching method; Tutoring elementary students |
| **Holley** | Teaching method; Hands-on examples and activities; Attending class; Understanding material |
| **Ida** | Not having to take another math class for some time |
| **Jan** | Teacher's teaching style of step-by step explanations; Teacher's willingness to help; Relaxed atmosphere of class |
| **Kay** | Learning the basics again; Increased confidence in math abilities due to tutoring elementary students |
| **Lynne** | Assistance of teacher; Being tutored by peer; Increase of knowledge |
| **Michele** | Writing tutoring reports; Recognized material was not as difficult as previously thought |
| **Nell** | Assistance of teacher; Being tutored by peers; Learning basics built confidence; |
| **Phoebe** | Teaching technique of "breaking down" problems; Hands-on activities; Teaching emphasis on making connections in mathematics; Deeper understanding of material; More comfortable with material |

**TABLE 4**

**Responses to Question 2**
**Factors Participants Commented on as Having Reduced Math Anxiety**

| NAME | *CC | IS | I | WC | MU | M | UC | EM |
|---|---|---|---|---|---|---|---|---|
| Anita | √ | √ | √ | | √ | √ | √ | √ |
| Barhara | | √ | √ | √ | | √ | √ | √ |
| Carolyn | √ | √ | √ | √ | √ | √ | √ | √ |
| Debra | √ | √ | √ | √ | √ | √ | √ | √ |
| Erin | √ | √ | √ | √ | √ | √ | √ | √ |
| Frankie | √ | √ | √ | √ | √ | √ | √ | |
| Gerry | | √ | √ | √ | √ | √ | √ | √ |
| Holley | √ | √ | √ | √ | √ | √ | √ | √ |
| Ida | √ | √ | √ | √ | √ | | | √ |
| Jan | √ | √ | √ | √ | √ | √ | √ | √ |
| Kay | √ | √ | √ | √ | √ | √ | √ | √ |
| Lynne | √ | √ | √ | √ | √ | √ | | √ |
| Michele | √ | √ | √ | √ | √ | √ | √ | √ |
| Nell | √ | √ | √ | √ | √ | √ | √ | √ |
| Phoebe | √ | √ | √ | √ | √ | √ | | √ |

*CC (Course Content); IS (Instructional Strategies); I (Instructor); WC (Writing Component); MU (Manipulative Use); M (Modeling); (UC) Usefulness of Course; EM (Evaluation Methods)

Initially, these 15 students were asked what factors they believed caused their mathematics anxiety to reduce while they were enrolled in a required mathematics course. Each of the 15 students provided one to five factors. Table 3 shows a summary of responses to Question 1, which were provided in Chapter IV.

Eleven of the 15 students (73 percent) responded by providing a factor relating directly to the actions or behaviors of the teacher. 'Willingness to help or provide assistance' was the most mentioned teacher behavior. The next three teacher-related behaviors most cited were teaching methods, step-by-step explanation, and hands-on activities. Other teacher-related factors, which students believe reduced their mathematics anxiety, were the way the teacher presented the material and encouraged the students. One student stated that her teacher provided test-taking tips. Another said that her teacher's teaching emphasis of making connections in mathematics was a factor in reducing her mathematics anxiety.

Six of the 15 students (40 percent) cited better understanding and/or increased knowledge as a factor that reduced their mathematics anxiety. While better understanding and/or increased knowledge was a factor cited, most students identified this factor in conjunction with some specific teacher behavior. Debra said, "My teacher really took her time to make sure that everyone understood the material." Erin stated, "The quality of the teacher and the quality of her really encouraging us to understand what was going on" helped in reducing her (Erin's) mathematics anxiety. In further comments, Erin stated that because she was not afraid to ask for help, she "was able to better understand the material" that she was having difficulty with during the course.

Five of the 15 students (33 percent) stated that an increase in confidence was a factor in reducing their level of mathematics anxiety. As with the factor of better understanding, an increase in confidence was usually mentioned in association with some teacher-related behavior. Carolyn believed that doing well in the course increased her confidence. She attributed doing well in the course to a mixture of her teacher's teaching methods, the simplicity of the course content, and her lowered intimidation once introduced to the content. Nell said that her teacher taught the basics within the content of the course. Nell stated, "Learning the basics helped me to build confidence and to be able to work through a problem on my own with no doubts."

These 15 participants whose mathematics anxiety had reduced were given this opportunity to respond freely when specifically asked what reduced their mathematics anxiety. In this situation, 11 of the 15 (73 percent) mentioned teacher behavior in some way – including willingness to help, teaching methods/strategies, and encouragement. These results suggest that the teacher is the main component of most factors, which students perceive as reducing their mathematics anxiety.

After being asked what factors they perceive as having reduced their mathematics anxiety, the 15 students were asked a question providing specific factors that may have related to their reduction in mathematics anxiety. The students were asked to comment if these specific factors related to their reduction of mathematics anxiety. The factors were as follows: 1) Course content; 2) Instructional strategies; 3) Instructor; 4) Writing Component; 5) Manipulative use; 6) Modeling; 7) Usefulness of course as related to major; and 8) Evaluation methods. Table 4 shows a summary of results to Question 2.

When provided with these specific factors as options, most students were able to relate the majority of the eight given factors to a reduction in mathematics anxiety. However, instructional strategies and the instructor were the only two factors commented on by all 15 students; that is, 100 percent of the students believed that instructional strategies and the instructor related to a reduction of their mathematics anxiety. Ninety-three percent of the students commented on the writing component, manipulative use, modeling, and/or the evaluation methods. Eighty-seven percent of the students believed that the course content related to their reduction in mathematics anxiety. Interestingly, the factor commented on by the fewest number of students (80 percent) was the usefulness of the course as related to their major.

Eight of the 15 students (53 percent) commented on all eight of the factors indicating that each related to the reduction of their mathematics anxiety in some way. Holley, a 20 year old enrolled in the geometry course, was one of the students who believed that all eight factors were related in some way to reducing her anxiety. She stated that the course content "made sense" to her and the hands-on activities had an impact on reducing her anxiety. Holley said that her instructor was very approachable. When discussing the writing component, she said that having to explain each step of a problem was beneficial to her. The teacher modeled problems and asked questions as she modeled the problems. Holley commented, "The interaction helped and allowed us to think about the situation." She believed the usefulness of the course was evident when she tutored elementary students. In addition, Holley stated that the different evaluation methods, used by the teacher, allowed her to think of a problem in different ways.

While the majority of these specific factors were commented on by the 15 participants as being related to their reduction of mathematics anxiety, the instructional strategies and the instructor were the two factors commented on by 100 percent of the students. Instructional strategies involve the instructor directly. These results support Question 1's results suggesting that the teacher is the main factor that students perceive as reducing their mathematics anxiety.

In an effort to support the results of Questions 1 and 2, a third question was asked of all 28 participants – the 15 students whose mathematics anxiety decreased during the semester and the 13 students whose mathematics anxiety increased during the semester. The question is as follows:

**Question 3:** *Overall, what factors do you believe would most reduce the mathematics anxiety of elementary education majors while enrolled in a mathematics content course?*

As with Questions 1 and 2, all responses to Question 3 were coded and analyzed. The researcher summarized and condensed the responses. The responses of the 15 students whose mathematics anxiety reduced are presented in Table 5. The responses of the 13 students whose mathematics anxiety increased are presented in Table 6. The responses of all 28 students were summarized and categorized. This summary is presented in Table 7.

**TABLE 5**

**Responses to Question 3 (Students Demonstrating Reduction)**
**Factors Identified by *Participants**

| Name | Factors |
|---|---|
| **Anita** | Predetermined course schedule; Explain concepts well; Teaching of relevant content |
| **Barbara** | Material is applicable to real life and future use as a teacher |
| **Carolyn** | Teacher's approach to class and course content; Use of concrete examples; Fair evaluation methods |
| **Debra** | Teacher presenting material at a slower pace; POWs and Journals |
| **Erin** | Quality of the instruction; Nurturing teacher; POWs |
| **Frankie** | Teaching methods; Course content |
| **Gerry** | Relaxed method of teaching; Tutoring elementary students using concepts learned in course |
| **Holley** | Discuss tutoring experiences with other students during class |
| **Ida** | POWs; Manipulative use |
| **Jan** | Tutoring elementary students using concepts learned in course; A variety of assignments |
| **Kay** | Provide class notes so students can listen in class |
| **Lynne** | The role of the teacher in content approach and presentation; Gaining greater confidence in my own ability to perform efficiently in a mathematics course |
| **Michele** | Using manipulatives and hands-on activities; Not as much emphasis on POWs |
| **Nell** | Providing sample test questions; Create study groups; Provide test-taking tips |
| **Phoebe** | Modeling; Provide sample test questions |

*Participants whose mathematics anxiety reduced based on the MARS-SV results

**TABLE 6**

**Responses to Question 3 (Students Demonstrating Increase)**
**Factors Identified by *Participants**

| Name | Factors |
|---|---|
| **Anne** | Provide a detailed test review |
| **Beverly** | Limit amount of homework |
| **Courtney** | Make students aware of the course content prior to the start of course; Allow students to have a hands-on part in teaching the course |
| **Della** | No change to course to reduce anxiety |
| **Edie** | Make students aware of the course content prior to the start of course from previous students; Begin with basic concepts for students to get "a feel" for teaching methods |
| **Faith** | More emphasis on content rather than teaching methods; Make students aware of the importance of all information throughout the course |
| **Ginny** | Allow students to correct tests for extra credit after returning graded tests |
| **Hannah** | Tutoring elementary students using concepts learned in class; Limit number of assignments and/or graded assessments |
| **Isabella** | Daily quizzes |
| **Jean** | Make students aware of the course content prior to the start of course from previous students |
| **Kim** | Step-by-step explanation; Review periodically during semester |
| **Laurie** | Effective teaching methods; Predetermined course schedule |
| **Marie** | Make students aware of the course content |

*Participants whose mathematics anxiety increased based on the MARS-SV results

TABLE 7

**Categorized Responses to Question 3**
**Summary of Factors Identified by All Participants**

| Category | Factors |
|---|---|
| **Course Content** | Teach relevant content; More emphasis on content rather than teaching methods; Make students aware of the course content prior to the start of the course; Make students aware of the importance of all information throughout the course |
| **Instructor** | Teacher's approach to class and course content; Role of the teacher in content approach and presentation; Nurturing teacher; Quality of the instruction; Relaxed method of teaching; Effective teaching methods; Teacher presenting material at a slower pace; Provide test-taking tips |
| **Instructional Strategies** | Predetermined course schedule; Provide class notes so students can listen in class; Provide sample test questions; Provide a detailed test review; Modeling; Step-by-step explanation; Explain concepts well; Allow students to correct tests for extra credit after returning graded tests; Make material applicable to real life and future use as a teacher; Review periodically during semester; Begin with basic concepts for students to get a "feel" for teaching methods; Tutoring elementary students using concepts learned in class; Discuss tutoring experiences with other students during class; Allow students to have a hands-on part in teaching the course; Create study groups; Provide test-taking tips |
| **Writing Component** | Journals; POWs; |
| **Manipulative Use** | Using manipulatives; Hands-on activities; Using concrete examples |
| **Evaluation Methods** | Fair evaluation methods; A variety of assignments; Limit number of assignments and/or graded assessments; Limit amount of homework; Daily quizzes; Not as much emphasis on POWs |
| **Other** | Gaining greater confidence in my own ability to perform efficiently in a mathematics course |

Both groups of students were asked what they thought, overall, would most reduce the mathematics anxiety of preservice elementary teachers while enrolled in mathematics content course. Each participant identified from one to three factors. These factors were categorized using similar factors as suggested in Question 2. The categories used were 1) Course Content, 2) Instructor, 3) Instructional Strategies, 4) Writing Component, 5) Manipulative Use, 6) Evaluation Methods, and 7) Other.

The 13 students, whose mathematics anxiety had increased, were also asked Question 3 to compare the responses of students whose anxiety decreased with those whose anxiety increased. As would be expected because of their participation through interviews and e-mail questionnaires, the 15 students whose anxiety decreased provided more factors. The students provided 31 comments in total. The 13 students, whose anxiety increased, provided 18 factors.

The responses of both groups were similar in that the most responses from each group were coded under the category "instructional strategies." Eight of the 18 (44 percent) comments provided by the students whose anxiety increased were coded "instructional strategies." Eleven of the 31 (35 percent) comments provided by the students whose anxiety decreased were coded "instructional strategies." It should also be noted that 19 of the 28 students (68 percent) provided at least one response that was coded "instructional strategies."

The "instructor" was the second most commonly coded category for the 15 students whose anxiety decreased. Seven of their 31 (23 percent) responses were coded "instructor." The "course content" was the second most commonly coded category for the 13 students whose anxiety increased. Six of the 18 (33 percent) responses were coded

"course content." While "course content" was coded for these six responses, each response could be interpreted as directly related to the "instructor" or to "instructional strategies." The results of Question 3 confirm the results of Questions 1 and 2 – the teacher is the main component of the factors that students perceive as having decreased their mathematics anxiety or the main component of the factors that students perceive would decrease their mathematics anxiety.

## Conclusions

Existing research suggests that mathematics anxiety can originate with the attitudes, behavior, and teaching techniques of teachers (Haralson, 2001; Jackson & Leffingwell, 1999; Norwood, 1994). The findings of this research study support the existing research in that 63 percent of the participants reported that their mathematics anxiety originated from teacher-related behavior.

There are numerous suggested methods for reducing mathematics anxiety; however, the research in this area is sparse. A number of studies have investigated the mathematics anxiety of preservice teachers enrolled in mathematics method courses, but no research studies were found that *specifically* focused on preservice elementary teachers enrolled in mathematics content courses.

The findings of this research study suggest that the reduction of mathematics anxiety of preservice elementary teachers enrolled in mathematics content courses also originates with a teacher-related behavior. While the researcher recognizes that this is a qualitative study and that generalizability is not an objective of qualitative research, some findings of this study are supported by existing research.

One may propose that the findings of this study are only applicable to the particular sample. However, the participants in this sample are from a large public university and range from freshman year students to senior year students. They were enrolled in 10 sections of four different mathematics content courses taught by four different instructors. Considering this information, it may be possible that the conclusions drawn from the results of this study are applicable to the general population of preservice elementary teachers.

The conclusions of the study are as follows:

1. Preservice elementary teachers' mathematics anxiety originates from some teacher-related behaviors. The behaviors include intimidating comments, inability to explain concepts, lack of enthusiasm for subject matter, and lack of patience with students.
2. Preservice elementary teachers' mathematics anxiety reduces as a result of some teacher-related behaviors. The behaviors include willingness to help and teaching methods. Specific teaching methods are step-by-step explanations and hands-on activities.
3. Preservice elementary teachers believe that certain instructional strategies would be the most effective way to reduce the mathematics anxiety of preservice elementary teachers. The instructional strategies include providing test reviews with sample test questions, explaining mathematics concepts thoroughly, incorporating hands-on activities into courses, and making the mathematics content relevant and useful as a future teacher.

## Implications

Mathematics instructors of preservice elementary teachers should make every attempt to assure that elementary teachers begin their teaching career with little or no mathematics anxiety. Typically, mathematics instructors of preservice elementary teachers are faculty members of their university's mathematics department and mathematicians. In *Beyond the Formulas – Mathematics Education for Prospective Elementary Teachers,* Cuff (1993) states,

> Mathematicians have started to recognize their responsibility in the mathematical education of pre-service elementary teachers. In the last decade, math courses have been developed specifically for elementary education majors. Unfortunately, these courses have often been viewed by the community of mathematicians as remedial. As a result, the courses have sought to remedy content deficiencies at the expense of addressing the more pressing issue of math anxiety. As mathematicians we often do not understand those students paralyzed by this anxiety. Consequently we tend, therefore, to ignore the problem and continue to teach the familiar and easy to teach area – the content (p. 221).

The instructors of mathematics courses for elementary education majors must be made aware of and understand the "pressing issue of math anxiety." They must also recognize its debilitating effects on students. These effects or consequences include avoiding mathematics courses, limiting one's selection of college and career choice, declining mathematics achievement, and feeling guilty or ashamed about mathematics (Armstrong, 1985; Betz, 1978; Brush, 1978; Burton, 1979; Donady & Tobias, 1977; Hendel, 1980, Preston, 1987; Richardson & Suinn, 1972; Tobias & Weissbrod, 1980). Considering the various educational systems in the United States and their attempt at

accountability, one of these effects – declining mathematics achievement – has far-reaching consequences and should be taken seriously.

The findings of this study suggest factors that increase or decrease mathematics anxiety. It is the intent of the researcher that the findings be disseminated among instructors of mathematics content courses for preservice elementary teachers and that the findings are implemented in their classrooms. This study's results originate in responses provided by students who perceived that certain factors actually decreased their mathematics anxiety. In addition, some of the results are derived from responses based on what students actually believe would be most effective in reducing the mathematics anxiety of preservice elementary education students.

It would be beneficial for instructors of these students to incorporate the practices suggested by the participants in this study. Instructors could informally monitor the success of these practices by discussing the suggested practices with their own students and determining what the students believe reduces their mathematics anxiety. In the event, that this study's suggested practices would not be successful, the suggestions provided by their own students could be implemented.

The findings of this research are based on the participants' perceptions and beliefs as to what reduces mathematics anxiety. Is it possible that if students "believe" something reduces their anxiety, then their anxiety will actually reduce?

## Recommendations

Further study is recommended in the following areas. Teacher-related behaviors were suggested to be the origin of what reduces mathematics anxiety and specific

behaviors were cited; these specific behaviors, with more in-depth descriptions, could be a focus of future research. It would be expected, but it should be noted that a deeper level of responses was obtained through individual interviews with follow-up e-mail questionnaires.

Another recommended study involves applying this study's suggested "instructional strategies." Two classes of the same course could be examined with one class being made aware of the effort to reduce anxiety implementing the suggested "instructional strategies." The second class taught would be taught without referencing mathematics anxiety and its reduction. When various instructional strategies are incorporated, students could be informed of the reasoning for incorporating particular strategies. Pre- and post-surveys (MARS-SV) could be administered to compare levels of mathematics anxiety.

Four different instructors taught the participants of this research study. However, with the exception of administering the MARS-SV surveys, the instructors were not a component of this study. The researcher recommends further research examining the views of the instructors including their understanding of mathematics anxiety and what, if any, techniques do they use to address the mathematics anxiety of their students.

## Summary

The significance of this study was based on existing research that mathematics anxiety originates with teacher behavior. It was the intent of the study to identify the factors that reduce the mathematics anxiety of preservice elementary teachers enrolled in mathematics content courses. This study's findings suggest that teacher behavior can

reduce mathematics anxiety. It is vital that instructors of preservice elementary teachers consider their behavior and the effects of their behavior in the classroom.

If instructors of preservice elementary teachers address mathematics anxiety issues at the university level, then future teachers will enter their classrooms with little or no mathematics anxiety. If future teachers have little or no mathematics anxiety, can the transfer of mathematics anxiety to students be eliminated? Is it possible to achieve the ultimate goal – total eradication of mathematics anxiety?

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# APPENDICES

# Appendix A

# Instrumentation

# Interview Questions

The interviewing method was semi-structured. Prior to beginning the interview, a definition of mathematics anxiety was read to the students. The definition is as follows: "The panic, helplessness, paralysis and mental disorganization that arises among some people when they are required to solve a mathematical problem" (Tobias & Weissbrod, 1980, p 63). The basic interview questions are listed below:

1. On a scale of 1 to 100, with 1 being low and 100 being high, what do you think your level of mathematics anxiety was when you entered the mathematics course in the spring of 2006? (Note: Students will be told to consider "50" as an average level of mathematics anxiety.) To what do you attribute your initial level of mathematics anxiety?

2. What is your first memory of mathematics anxiety? Has your mathematics anxiety continued throughout your academic career since this first memory?

3. On a scale of 1 to 100, with 1 being low and 100 being high, what do you think your level of mathematics anxiety was when you completed the mathematics course in the spring of 2006? (Note: Students will be told to consider "50" as an average level of mathematics anxiety.) To what do you attribute this level of mathematics anxiety?

4. How did your feelings about mathematics change during the semester? Explain and give an example.

5. How did your understanding of mathematics change during the semester? Explain and give an example.

6. How did your change in feelings about mathematics affect your understanding of mathematics? Explain and give an example.

7. How did your change in understanding mathematics affect your feelings about mathematics? Explain and give an example.

8. According to the MARS-SV survey results, your level of mathematics anxiety reduced during the semester. What specific factors do you believe caused your level of mathematics anxiety to reduce?

9. Comment on the following as to how each related to the reduction of mathematics anxiety while enrolled in the mathematics course:

| | | |
|---|---|---|
| Course content? | Instructional strategies? | Instructor? |
| Writing component? | Manipulative use? | Modeling? |
| Usefulness of course as related to major? | | Evaluation Methods? |

10. Considering this course is developed and taught in a manner to "understand math in a positive way," what would you do to improve the course in relation to reducing mathematics anxiety?

**Mathematics Anxiety in Elementary Education Majors Enrolled in Mathematics Content Courses**

**Demographic Questionnaire**

**Please complete the following questionnaire. If a choice is given, please circle the appropriate one.**

Name: _____ Email Address: _____

Age: _____ Sex: M F

Mathematics Course Presently Enrolled In: 1100 1201 1202 2203

Previous College Mathematics Courses and Grades:

| | Course | Grade |
|---|---|---|
| 1. | | |
| 2. | | |
| 3. | | |
| 4. | | |

ACT Composite Score: _____

ACT Mathematics Score: _____

If you do not know the ACT information, just leave it blank. It would be helpful if you could find out this information and you will be asked to provide it at a later date.

## E-Mail Questionnaire 1

1. According to the MARS-SV survey results, your level of mathematics anxiety reduced during the semester. What specific factors do you believe caused your level of mathematics anxiety to reduce?

2. Comment on the following as to how each related to the reduction of mathematics anxiety while enrolled in the mathematics course:

| | | |
|---|---|---|
| Course content? | Instructional strategies? | Instructor? |
| Writing component? | Manipulative use? | Modeling? |
| Usefulness of course as related to major? | | Evaluation Methods? |

3. Overall, what factors do you believe would most reduce the mathematics anxiety of elementary education majors while enrolled in a mathematics content course?

# E-Mail Questionnaire 2

Consider the following definition of math anxiety as you complete the questions and answer the questions based on your experience during your math course in the spring of 2006.

Mathematics Anxiety - "The panic, helplessness, paralysis, and mental disorganization that arises among some people when they are required to solve a mathematical problem" (Tobias & Weisbrod, 1980, p. 65).

1. On a scale of 1 to 100, with 1 being low, 100 being high, and 50 being average, what do you think your level of mathematics anxiety was when you entered the mathematics course in the spring of 2006? To what do you attribute your initial level of mathematics anxiety? 5

2. On a scale of 1 to 100, with 1 being low, 100 being high, and 50 being average, what do you think your level of mathematics anxiety was when you completed the mathematics course in the spring of 2006? To what do you attribute this level of mathematics anxiety?

3. According to the math anxiety rating scale survey, your level of mathematics anxiety increased during the semester. What specific factors do you believe caused your level of mathematics anxiety to increase? Please explain and discuss thoroughly.

4. Overall, what factors do you believe would most reduce the mathematics anxiety of elementary education majors while enrolled in a mathematics content course? Please explain and discuss thoroughly.

5. Grade in math course taken during spring 2006?
   ACT math score?
   ACT composite score?

## E-Mail Questionnaire 3

Please consider the following statement and answer the following question:

*Educational research has suggested that "mathematics anxiety can originate with the attitudes, behavior, and teaching techniques of teachers" and that "teachers can transfer mathematics anxiety" to their students.*

Do you recall any specific situations during your education that would support this statement? If so, please describe these situations.

# Appendix B

# Course Syllabi

# First course: SURVEY COURSE

MATH [redacted] SPRING 2006 INSTRUCTOR: [redacted]

Office: [redacted] Office Hours:
TBA

Phone: [redacted] Email:

**TEXT:** *Statistical Reasoning for Everyday Life, 2nd ed.*, Bennett, Briggs, Triola–required. *(solutions manual—optional)*

**MATERIALS (required):** A scientific calculator with logarithmic and exponential capabilities. Non-programmable graphing calculators are allowed. Formulas may NOT be entered into the memory of the calculator for use during a test or quiz. The instructor has the right to check your calculator for this. *Bring your calculator to class every day and learn how to use it!*

**ATTENDANCE** will be taken regularly. Once behind it is very difficult to catch up. If you must be absent, it is your responsibility to get the notes and assignments from a classmate (and read through the notes and attempt the assignment) before the next class period or before coming to office hours for help. **OFFICE HOURS** are for students who attend class regularly to stop by for help on material covered in class, homework questions, etc. Office hours are NOT a substitute for attending class. I will NOT reteach material covered during a class that you miss.

**ACADEMIC HONESTY** is expected of students enrolled in this course. See the Code of Student Conduct for expectations of students and instructors. **DISRUPTIVE BEHAVIOR** will not be tolerated. Students who habitually cut up, talk too much, come in late, or otherwise interfere with class running smoothly will be given one warning that continued such action will result in dismissal from the course. **Turn off your cell phone during class.**

| | | | |
|---|---|---|---|
| **GRADES:** | 3 tests | = 45% | **A** = 90.00-100% |
| | quizzes(best 5 of 7) | = 20% | **B** = 80.00-89.99% |
| | 2 projects | = 10% | **C** = 70.00-79.99% |
| | final exam | = 25% | **D** = 60.00-69.99% |
| | | | **F** = below 60% |

**Quizzes** will be given in class and will be announced in advance. Your two lowest quiz grades will be dropped at the end of the semester. **NO** makeup quizzes will be given.

**Make up Tests** – Permission to take a makeup test must be obtained **in advance**. In case of an emergency, email (preferred) or call my office as soon as possible. Do NOT wait until tbe next class meeting to contact me about a makeup. If permission to take a makeup test is obtained, that makeup test must be completed **within 1 week** of the missed test *in the Math Department's makeup lab.*
Test dates will be announced at least 2 weeks in advance.

**Projects** – For eacb calendar day that a project is late, 5 points will be deducted from the project grade. No project will be accepted more than 1 week after its due date. No project grades will be dropped.
Projects will be announced at least 2 weeks in advance.

**HOMEWORK** will be assigned eacb day but will not be graded. However, if you wish to succeed in this course, the recommended assignments *must* be completed. Many of the answers are in the back of your text, and otbers will be given to you throughout the semester. You should check your answers and note any that you have questions about. A limited amount of time will be given in class to ask questions about the homework. If all of your questions are not answered during class, you should come by my office for belp.

**FINAL EXAM:** *comprehensive and required.*
*Please read the schedule booklet for final exam time and date.*

**This course can be used to meet 3 credit hours toward the general education requirement for analytical reasoning. See pg 69 of the [redacted] catalog for more information.**

[redacted] I will use tbis to post announcements, grades, daily assignments, and handouts. You will use this to email me, to check test and quiz grades as well as your current course grade, to find out the assignment for a day you must be absent, and to find answers to homework problems not in the back of the text. *NOTE: If you do not plan to regularly check your [redacted] email, you must forward your [redacted] to your preferred address. Otherwise, you will miss important announcements.*

# Second course: NUMBER SENSE AND PROBLEM SOLVING

Instructor: [redacted] Spring 2006
Office: [redacted]
Phone: Office: [redacted]
E-mail address: [redacted]
Office Hours: [redacted]

**COURSE DESCRIPTION:**

This course is specifically designed to provide the student with a working knowledge of mathematics, the use of concrete teaching materials and models, and the importance of "understanding" before practice. The content rich mathematics course is designed for, but not limited to, pre-service teachers of grades K-6.

Written and oral communication, problem solving, reasoning, and making mathematical connections will be a vital part of this course. The course will emphasize open-ended problem solving using manipulatives for concept development and understanding. In particular, the course will provide a wide variety of learning activities involving critical thinking skills and cooperative learning groups. Assessment and question types will be varied and a part of the learning/teaching emphasis.

**COURSE OBJECTIVES:**

The student will have the opportunity to:

- develop conceptual understanding of important mathematical principles and how they are interconnected
- increase knowledge of numbers and develop number sense
- explore open-ended problem solving
- use manipulatives and experience a variety of teaching methods in developing understanding
- develop critical thinking skills through problem-solving experiences
- express mathematical ideas clearly and correctly
- develop an appreciation for the power and beauty of mathematics

**GRADING PROCEDURE:**

Grading Scale: 90-100% A 80-89.9% B 70-79.9% C 60-69.9% D Below 60 F

| | | |
|---|---|---|
| Semester grades: | 4 tests | 48% |
| | 4 POW's (no make-ups) | 12% |
| | Journals (no make-ups) | 5% |
| | In-class quizzes/Test 1 Reflections (no make-ups) | 10% |
| | Final Exam | 25% |
| | Total | 100% |

**ATTENDANCE AND MAKE-UP POLICY**: *****Please read carefully.*****

Attendance is mandatory and extremely crucial to your success in this class. Roll will be taken. Attending regularly is a necessity so as not to get behind. Once behind, it is difficult to "catch up." Many of the activities done in class are not described in the book and cannot be "made up" by reading the book or getting someone else's notes. It is important that you are here to "experience" the lesson. Attending "regularly" does not mean 2 days out of 3. Even if you "only" miss one class a week, you are missing 1/3 of the material. That means you start the class with approximately 67%.

If you are absent, it is your responsibility to find out what is covered in class and what the assignment is. You are expected to have all work completed when you return to class and be prepared for class. Get the phone numbers and e-mail addresses of at least 2 classmates and contact them for information. If you will be out of class for more than one day, please call me or e-mail me to inform me.

Also, plan to be here on test days. These dates are in bold print on your syllabus. Tests are extremely difficult to make up. **NO** make-ups will be given for any other missed graded work.

If you do miss a test, please contact me by phone or e-mail no later than the day of the test. Please do not wait until you return to class to speak to me about making up a test.

**TARDINESS:**

Please be on time for class and plan to stay the entire time. It is very distracting when students walk in late. If you are late for some reason, please enter the classroom quietly and speak to me after class. If you must leave early, please talk with me before class. Excessive tardiness will not be tolerated and may affect your grade. Journals will be given in the first 5 minutes of class and **NO** make-ups will be given for this type of assignment.

**DISRUPTIVE BEHAVIOR:**

This is not usually a problem, but disruptive behavior will not be tolerated. Also, please have cell phones turned to "silent" mode for class.

**ACADEMIC HONESTY:**

All students are responsible for adhering to the highest standards of honesty and integrity in every aspect of their academic careers. The penalties for academic dishonesty can be severe and ignorance is not an acceptable defense at [redacted]. The [redacted] Student Code of Conduct can be accessed at [redacted]

**LEARNING GROUPS:**

As part of the learning process and alternative evaluations, you will be assigned to a group consisting of three or four members. You will sit together and work together on many aspects of the course. The groups will be changed periodically during the semester.

**LEARNING DISABILITIES:**

Students with unique learning needs are encouraged to see me during office hours to discuss course requirements and approved accommodations. Students who seek information about disability services should contact the Office of Disability Services, [redacted]

**NAMES AND PHONE NUMBERS OF CLASSMATES:**

***SYLLABUS: MATH*** [redacted] ***INSTRUCTOR:*** [redacted]

**TEXT:** A Problem Solving Approach to Mathematics for Elementary School Teachers, Eighth Edition. (Authors: R. Billstein, S. Libeskind, J. Lott )

**ACTIVITY TEXT:** Mathematics Activities for Elementary School Teachers A Problem Solving Approach, Fifth Edition. (Authors: D. Dolan, J. Williamson, M. Muri)

**TENTATIVE OUTLINE:** (If changes are to be made, students will be informed.)

PROBLEM SOLVING
- Strategies for Problem Solving
- Critical Thinking
- Exploration with Patterns
- Number Sequences
- Relations and Functions

**TEST 1** **FRIDAY, FEBRUARY 10**

WHOLE NUMBERS
- Numeration Systems
- Patterns for Numeration
- Place Value
- Conversions Between Bases
- Operations and Computations in Different Bases
- Primes, Composites, and Factorization
- Divisibility

NUMBER THEORY
- Greatest Common Divisor and Least Common Multiple

**TEST 2** **FRIDAY, MARCH 10**

THE SYSTEM OF INTEGERS AND ELEMENTARY NUMBER THEORY
- The System of Integers
- Addition and Subtraction with Integers
- Multiplication and Division with Integers

FRACTIONS
- Fraction Concepts–Relative Size, Order, Equivalent Fractions
- Addition and Subtraction with Fractions
- Multiplication and Division with Fractions

**TEST 3** **MONDAY, APRIL 3**

DECIMALS: RATIONAL AND IRRATIONAL NUMBERS
- Introduction to Decimals
- Decimal Number Concepts - Place Value, Relative Size, Order
- Conversions Between Fraction and Decimal Forms
- Terminating and Repeating Decimals
- Basic Operations with Decimals
- Ratio and Proportion
- Percent
- Equivalences Among Fractions, Decimals, and Percents

**TEST 4** **WEDNESDAY, MAY 3**

# Third course: MEASUREMENT AND GEOMETRY

Syllabus Math [redacted] Spring 2006 e-mail address: [redacted] nstructor: [redacted] Office Hours: **MW: 12:30 – 2:00**Office: [redacted] Office Pbone: [redacted] **Th: 1:00 – 2:00 or by appointment.**

**Text and Other Materials:** Bundle including A Problem Solving Approach to Mathematics for Elementary Scbool Teachers, 8th edition, by Billstein, Libeskind and Lott; Mathematics Activities 5th edition for Elementary School Teachers by Dolan, Williamson, and Muri; *MyMathLab* Student Access Code, and Manipulative Kit.
**Also Required:** Patty Paper Geometry, by Michael Serra, Key Curriculum Press(paperback); patty paper (approximately 1/4 of a box); protractor; straight-edge/ruler, Big Handout (see below).

**Big Handout (BH):** These are pages you will need during the semester and are located in semester book under a folder named Big Handout. Print them out, hole punch them, and put them in a binder to have with you for ***each class***. Some pages are to be completed in class, while others will be assigned for homework.

**Goals and Expectations:** To develop an appreciation of geometry and how it relates to the real world; to develop a deep understanding of gcometric concepts; use the language of mathematics to exprcss mathematical ideas and solutions precisely; ***expect to spend an average of 6 hours per week on homework, POW's, and going over class notes.***

**Attendancc:** Attendance is mandatory. Roll will be taken. Since this is not a lecturc class, it is especially important to attend class. Learning is through hands-on activities, which will be difficult to understand and make up if not in class. If you miss class, you must talk to a member of the group or classmate to find out what was covered in class. It is your responsibility to make up the missed material. You will be lost in class if you have not gone over the previous day's notes. If you are out for more than 1 day, you should email me and let me know what's going on.

**Make Up Policy:** If you must miss a test you **MUST** email me or call me and leave a message on my recorder **on the day of the test**. I will then decide based on your excuse whether you are allowed a makeup test. *Each student is allowed at most 1 makeup exam.* There will be NO MAKEUPS on journals, quizzes, or POW's period.

**Grading:** (Tentative)

| | | **Grading Scale:** |
|---|---|---|
| Journal: | 1 % | |
| Quizzes MML (best 5 of 6) | 5 % | A: 90 – 100 % |
| Homework/Participation | 5 % | B: 80 – 89.9% |
| POW's – top 3 of 4 | 12 % | C: 70 – 79.9% |
| **Project: | 8 % | D: 60 – 69.9% |
| Tests – 4 at 10% each: | 44 % | F: 0 – 59.9% |
| Final Exam- Comprehensive: | 25 % | |

**Note:** Grades will be posted on semester book so you can check your current grade at any time and make sure your grades were entered accurately. Also any announcements or emails will be put on semester book, so **please check your PAWS account *at least every other day*.**

**Quizzes:** There will be 6 quizzes throughout the semester assigned in class. They will be done using a program *MyMathLab* (MML) which came with your book. You will need to register first using the course ID number I will give you. This program can be used from any computer which has access to the internet and must use Internet Explorer. All public access labs on campus have the necessary plug-ins installed to run this program. You can get a list of these labs by going to XXXXXXXXXXXX. The problems on the quiz will be just like homework problems assigned so if you are doing your homework and asking questions on the ones you have trouble with, you should do well on these quizzes. The due date of the quiz will be posted in MML. No late quizzes will be accepted. You can practice problems on the quiz before by going to the Study Plan in MML and working all the problems listed in each section that were also assigned for homework. You will also have 10 tries for each quiz in case of some unforeseen computer problem or power outage. Do not start taking the quiz unless you have time to complete it. Once you begin a quiz you must finish it. ***No quizzes can be made up for any reason.***

**Homework/Participation:** At the beginning of each class there will be a short quiz given to make sure you are in class and to test whether you have completed your homework. The quiz will be a homework problem or one just like it. A couple (2) of homework grades will be dropped. ***No homework grades can be made up for any reason.***

**POW's:** POW's are due at the ***beginning*** of class on the assigned date. ***They will not be accepted late for any reason!!!*** I give you plenty of time to complete the POW's so use all the time I give you!! Once you get the POW (which are posted in [redacted] under a folder named POW's) you should read it and see if you know where to begin. If you don't know how to start I will be happy to help you if you come by my office, as long as you don't wait until a couple of days before it is due. I will also be happy to read what you have written to see if it makes sense and to see if you are on the right track and to make suggestions. In other words I want you to be successful with these POW's! The purpose of the POW's is to make sure you can write mathematics in a logical, sensible way that can be easily followed. This ability is very important for students as well as future teachers. One of the main objectives of the NCTM Standards is to be able to communicate mathematics.

****Project:** The project is a service-learning project. Each student will be required to attend an orientation session and then visit a local elementary school 6 times during the semester and tutor math. A journal will be required after each visit as well as a final paper on the experience. If your schedule absolutely will not allow for these visits (times during the school day), an alternative project will be assigned.

**Note**: All tests and POW's must be completed with a legible handwriting and an easy to follow solution. Your grade on an assignment will be negatively affected if it cannot be read or understood. Please note a grade on any work is neither a judgment of you as a person nor the amount of time you spent completing the assignment, but rather of the quality of your work. Therefore, your grades are based on the mastery of the material.

# Fourth course: PROPORTIONAL AND ALGEBRAIC REASONING

Instructor: [redacted]
Office: [redacted]
E-mail address: [redacted]
Office Hours: [redacted]

Spring 2006
Phone: [redacted]
Fax: [redacted]

**COURSE DESCRIPTION:**
**MATH [redacted] Proportional and Algebraic Reasoning (3 credit hours)**
*Prerequisites: Professional Practice Block 1; 12 semester hours of mathematics including Math 1[redacted] and [redacted]; concurrent enrollment in [redacted] and [redacted] 2 hours lecture, 2 hours lab/field experience. Mathematics content course designed to be integrated with Praxis II with the principles and structures applied to mathematical reasoning applied to the grades K-5 classroom.* Development of a connected, well balanced view of mathematics; interrelationship of patterns, relations, and functions; applications of proportional and algebraic reasoning in mathematical situations and structures using contextual, numeric, symbolic and graphic representations; written communication of mathematics.

**COURSE PURPOSE AND GOALS:**
MATH [redacted] builds on the foundation of mathematics concepts of problem solving, number and operations, measurement and geometry developed in MATH [redacted] and MATH [redacted] (Prior completion of these two courses is required.)

Concurrent enrollment in [redacted] (Mathematics Theory and Practice in the Elementary Grades) and [redacted] (Elementary and Middle School Science) is required, since there are numerous crossovers in terms of content, pedagogy, fieldwork experiences, and supervision.

The student will:

- increase knowledge, understanding, and application of proportional and algebraic reasoning
- develop the mathematical processes of "finding, describing, explaining, and predicting" through the use of patterns
- use multiple representations (contextual, tabular, numeric, symbolic and graphic) to understand and make connections among mathematical concepts
- understand how math concepts evolve from concrete examples to generalizations expressed by function rules
- understand and analyze change in various contexts
- develop proportional reasoning skills by comparing quantities, looking at relative ways numbers change, and thinking about proportional relationships in linear functions.

- develop conceptual understanding of important mathematical principles, their interrelationship, and their vertical development

**SITE-BASED FIELD EXPERIENCE:**

MATH [redacted] includes required site-based fieldwork observing K-5 mathematics lessons/classes. This fieldwork will occur at local public elementary schools. Efforts will be made to coordinate fieldwork with [redacted] and [redacted] There will be a specific assignment of school, teacher, classroom, days, and times. Additional information will be given on the fieldwork information sheet.

**TEXTS:**

***The same text that is required for [redacted] will be a reference book for this course.
Van de Walle, J. (2001). *Elementary and middle school mathematics, 4th ed.* Addison Wesley Longman Press.

***Material from these books will be used. Purchase is optional. They are available through NCTM at www.NCTM.org.
National Council of Teachers of Mathematics (2001). *Navigating through algebra in grades PreK – 2*
National Council of Teachers of Mathematics (2001). *Navigating through algebra in grades 3 – 5*

**CONTENT OUTLINE:**

I. Algebraic Thinking
II. Patterns and Relationships
III. Functions and Change
IV. Proportional Reasoning

**GRADING PROCEDURE:**

Grading Scale: 90-100% A 80-89.9% B 70-79.9% C 60-69.9% D Below 60 F

| | | |
|---|---|---|
| Semester grades: | 3 tests | 42% |
| | Written Math Assignments/Homework, Class Participation Quizzes | 10% |
| | Fieldwork Component reflections, written assignments (10 math lesson observation journals) | 23% |
| | Final Exam | 25% |
| | | 100% |

There will be a written assignment/homework participation quiz/activity during each class period that is not a test day. These will be graded and one will be dropped at the end of the semester (12 of 13). These will frequently be given at the beginning of class. There will be no make-ups for absences or late arrivals. A missed assignment or quiz

will be recorded as a zero on the assessment. **Only partial credit will be given for other assignments/material turned in late.**

Class Schedule – Spring 2006
Please note: Any Tuesday or Thursday session could have class and field experience interchanged if circumstances warrant. If your field experience is scheduled at a different time, please make sure the 1:30 – 3:30 TTh class times remain reserved for your attendance in class if schedules are changed.

| **Tuesday** | | **Thursday** | |
|---|---|---|---|
| 1/17 | Course Introduction<br>Algebraic Thinking | 1/19 | Algebraic Thinking<br>Patterns and Relationships |
| 1/24 | Patterns and Relationships | 1/26 | Patterns and Relationships |
| 1/31 | Patterns and Relationships | 2/2 | Field Experience Orientation |
| 2/7 | **Test 1** | 2/9 | Field Experience – Week 1 |
| 2/14 | Functions and Change | 2/16 | Field Experience – Week 2 |
| 2/21 | Functions and Change | 2/23 | Field Experience – Week 3 |
| 2/28 | **Mardi Gras Holiday** | 3/2 | Field Experience – Week 4 |
| 3/7 | Functions and Change | 3/9 | Field Experience – Week 5 |
| 3/14 | Functions and Change | 3/16 | Field Experience – Week 6 |
| 3/21 | Functions and Change | 3/23 | **Test 2 -** [redacted]<br>LEAP Testing in Schools |
| 3/28 | Proportional Reasoning | 3/30 | Field Experience – Week 7 |
| 4/4 | Proportional Reasoning | 4/6 | Field Experience – Week 8 |
| 4/11 | **Spring Break** | 4/13 | **Spring Break** |
| 4/18 | Proportional Reasoning | 4/20 | Field Experience or Class |
| 4/25 | Proportional Reasoning | 4/27 | Field Experience – Week 9 |
| 5/2 | **Test 3** | 5/4 | Final Class<br>Summarize,<br>Review for Final Exam |
| [redacted] | [redacted] | | |

# VITA

DesLey Viator Plaisance earned the degrees of Bachelor of Science in Mathematics Education and Master of Science in Applied Mathematics from Nicholls State University, Thibodaux, Louisiana.

Plaisance worked as a graduate assistant in the Department of Mathematics and the College of Education at Nicholls State University. She taught high school mathematics in the Iberia Parish School System and in the East Baton Rouge Parish School System.

Currently, Plaisance is a mathematics instructor at Louisiana State University – Baton Rouge. She held this position prior to her enrolling in the Southern University Science and Mathematics Education Doctoral Program and while completing the program.